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Geology of Tully and Little Townships, District of Cochrane

by

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Abstract

Tully and Little townships are approximately 35 km northeast of Timmins and are underlain by Neoarchean rocks of the Abitibi Subprovince of the Superior Province of the Canadian Shield. Ultramafic, mafic and minor felsic metavolcanic rocks with intercalated clastic and chemical metasedimentary rocks comprise the Kidd–Munro assemblage which underlies the western and southern part of Tully Township. Rocks of this assemblage are in fault contact with intermediate and felsic, plagioclase- and clinopyroxene- porphyritic metavolcanic and clastic metasedimentary rocks of the Duff–Coulson–Rand assemblage in the central part of the map area. Ultramafic metavolcanic and intrusive rocks, and mafic and felsic metavolcanic rocks of the Stoughton–Roquemaure assemblage underlie the northeast corner of Little Township and are in conformable contact with rocks of the Duff–Coulson–Rand assemblage. Clastic metasedimentary rocks consisting of turbidites underlie the southwest corner of Tully Township and are correlated with the Hoyle assemblage. This assemblage is in both fault and stratigraphic contact with the Kidd–Munro assemblage.

Within the Kidd–Munro assemblage, a first generation east-northeast-trending foliation is locally overprinted by northerly trending fractures and a penetrative foliation. Within the Duff–Coulson–Rand assemblage a strongly developed northwest-trending foliation is parallel to stratigraphy and locally overprints a weakly developed east-northeast-trending foliation. No outcrop of the Stoughton–Roquemaure assemblage is exposed in the map area; however, stratigraphic units are northwest-trending similar to those in the Duff–Coulson–Rand assemblage. Northeast-, northwest- and north-trending faults occur throughout the map area and many extend regionally. The northeast- and northwest-trending faults are commonly brittle-ductile structures which display complex sense of movement and may locally represent thrust planes. The north-trending faults are commonly the youngest structures in the map area and display brittle vertical movement, calcite-filled fault gouge and weak to moderate hematite alteration.

Low grade greenschist metamorphism has affected the entire map area and primary volcanic mineralogy and textures are commonly well-preserved. Chlorite is most common in pelitic metasedimentary rocks and the absence of biotite indicates low grade metamorphism. Hydrothermal alteration associated with gold mineralization is characterized by iron carbonate and white mica with minor green mica, vein chlorite, tourmaline, biotite, pyrite and arsenopyrite. The alteration appears to be most commonly associated with the northeast-trending faults; however, some industry geologists believe the north-trending faults provide some control on the mineralization. Alteration characteristic of base metal hydrothermal systems was not observed in the map area; however, some of the felsic metavolcanic rocks in the central part of Tully Township are albitized and may be favourable hosts for base metal mineralization.

The Nickel Offsets, Texmont and Frankfield gold deposits are hosted in east-northeast-trending shear zones in the Kidd–Munro assemblage in Tully Township. Significant gold mineralization associated with northeast-trending faults occur in the central part of Tully Township near the contact between the Kidd–Munro and Duff–Coulson–Rand assemblages.

There is excellent potential for more discoveries in this part of the map area. Gold mineralization is reported in felsic metavolcanic rocks of the Stoughton–Roquemaure assemblage in northeastern Little Township, an area which has received only modest exploration.

Copper and zinc mineralization hosted in graphitic and cherty exhalite units occur in the central part of Tully Township near the contact between the Kidd–Munro and Duff–Coulson–Rand assemblages. Graphitic metasedimentary rocks in this area contain elevated zinc and copper and indicates economic mineralization may occur in the map area or to the northwest in adjacent Duff and Lucas townships.

Introduction

Tully and Little townships are bounded by latitudes 48°42'22" and 48°47'48" north and by longitudes 80°56' and 81°12'15" west (Figure 1). The area, approximately 184 km^2, was mapped at 1:20 000 scale to encourage mineral exploration and to improve the geological data base. The centre of the area is approximately 35 km northeast of Timmins. Secondary roads leading north from Highway 610 provide access to the western part of Little and the eastern part of Tully townships. A secondary road leading east from Highway 655 through Prosser Township provides access to the Intex gold deposit in western Tully Township. Access to most of the area is provided by helicopter during the summer and by snow machine or all-terrain vehicle in the winter.

History of Exploration

Prior to the discovery, in 1964 of the Kidd Creek base metal deposit there is no exploration reported in the map area. From 1964 to 1969 several companies acquired and explored several parts of the map area without making any significant discoveries. In 1969, McIntyre Porcupine Mines Limited explored ground in the western part of Tully Township and discovered gold mineralization in the north 1/2 of Lot 11, Concession I and in the south 1/2 of Lot 12, Concession III (Bright 1971). Subsequent work by various companies have outlined 650 000 tons at 0.23 ounce gold per ton on the southern of two deposits (Nickel Offsets Deposit) and 114 000 tons at 0.22 ounce gold per ton on the northern deposit (Intex Deposit). A third deposit (Frankfield Zone) of 191 000 tons at 0.23 ounce gold per ton was discovered approximately 2 km east of the Intex deposit in 1974 by Intex Mining Company Limited. Each of these deposits is overburden covered and their discovery was made by diamond drill testing of airborne electromagnetic conductors. Each deposit occurs in easterly trending shear zones and is associated with graphitic metasedimentary, mafic metavolcanic and ultramafic metavolcanic rocks.

In 1972, Hollinger Mines Limited explored the central part of Tully Township and encountered, in a single diamond drill hole, a quartz vein assaying 0.4 ounce gold per ton in the south 1/2 of Lot 7, Concession IV. Subsequent work did not outline any continuous mineralization although several anomalous gold and copper assays were reported. In 1987 and 1991, Esso Minerals Canada and Homestake Canada Limited carried out further exploration in the same area and their diamond drilling encountered gold mineralization associated with arsenopyrite, graphite and altered mafic metavolcanic rocks. Gold assays of up to 175 g/t over 0.3 m were reported; however, continuous mineralization was not defined.

In 1982 Newmont Exploration of Canada Limited carried out extensive exploration in the central parts of Tully Township and several diamond drill holes were sunk to test airborne electromagnetic conductors. Gold mineralization associated with arsenopyrite, graphite, massive pyrite, minor copper and zinc was encountered and assays over 1500 ppb gold were returned from five drill holes (the best assay returned 1.41 oz/ton gold over 1.5 m). Continuity of

mineralization was not established and further work was not done.

In the mid 1980's, exploration in the northeastern part of Little Township concentrated on diamond drill testing of airborne electromagnetic conductors. Norcen Energy Resources Limited reported a gold assay in graphitic chert of 0.13 but did not specify the units. The author infers that the assay is in ounces of gold per ton which is significant. Further work in the area did not encounter additional mineralization and no further work has been reported.

Base metal exploration began in the area shortly after discovery of the Kidd Creek ore body in 1964. Several diamond drill holes have been sunk to test airborne electromagnetic conductors which resulted in the discovery of the gold mineralization described above. Newmont Exploration of Canada Limited (1982) encountered zinc and copper mineralization in massive sulphides and graphitic metasedimentary rocks (27600 ppm and 7600 ppm respectively over 3.5 feet) in the north 1/2 of Lot 8, Concession IV, Tully Township; however, adjacent drill holes failed to encounter mineralization of similar grades.

A number of mining claims were in good standing in the map area as of December 1995.

Previous Geological Work

Ginn et al. (1964) compiled the first large scale map covering Tully and Little townships at 1:253 440 scale and this map was revised and reinterpreted by Pyke et al. (1973). Bright and Hunt (1971) compiled the geology and geophysics of Tully Township at 1:15 840 scale which was revised by Hunt et al. (1980). Airborne electromagnetic and total intensity magnetic survey Maps 81056 and 81057 (OGS 1988a, b) cover the map area. Several companies have submitted geological compilation maps covering parts of Tully Township for assessment work credits and these maps were consulted by the author.

Present Survey

Tully and Wark townships were mapped at 1:20 000 scale during the 1995 field season. The mapping crew consisted of the author and one geological assistant. A combination of outcrop mapping, examination of diamond drill core, compilation of geological and geophysical data and use of computer enhanced images of geophysical data were used to complete the geological maps. Approximately 22 outcrop areas were examined and sampled where appropriate.

Diamond drill core stored at the Ministry of Northern Development and Mines, Drill Core Library in Timmins was examined and in some places sampled. Exploration companies were approached and asked permission to make drill core, bedrock chips, drill logs and other data available for integration onto the maps. The locations of drill hole collars provided on drill logs and sketches in assessment and private company files were transferred to the base maps. The locations of these holes are referenced to lot and concession boundaries or to recognizable

geographic features in each township and as very few of the drill holes were actually located in the field there may be some error in their location. Based on the prevailing vertically dipping style of the geology, diamond drill holes were projected vertically to surface based on the azimuth and declinations recorded on the drill logs. Most drill data was, on average, examined only once by exploration companies with the greatest emphasis most commonly placed on economic mineralization. The present survey examined the data with respect to regional geological units with emphasis on the position and nature of contacts between major rock types. The geology of approximately 174 diamond drill holes (Appendix 1) is included on Map P.3351 (back pocket). Drill core examined by the author show no prefixes before the codes on the map. Geological codes taken from the drill logs but where no core was examined by the author are prefixed by the letter "D" on Map P.3351 (back pocket).

The locations of approximately 34 reverse circulation drill holes (Appendix 1) are included on Map P.3351 (back pocket). These holes are essentially vertical and designed to prospect the overburden for glacially entrained minerals of economic importance, most commonly gold and base metals. It is common practise when boring these holes to penetrate at least 1.5 m into the bedrock. Bedrock chips or core are commonly examined, sampled, described on the drill logs and in some instances stored for future use by the operators of the exploration programs. It is the author's experience that bedrock chips examined only in the field are commonly misidentified and therefore, more reliable data such as outcrop and diamond drill core should be consulted wherever possible to confirm the geology.

There are numerous geophysical and geological reports and maps available to the public at the Resident Geologist's Office, Ministry of Northern Development and Mines, Timmins. All of these files were examined and pertinent data were incorporated onto the map.

Airborne total intensity magnetic and electromagnetic surveys carried out for the Ontario Geological Survey in 1988 were used extensively to delineate geological contacts and to infer the presence of fault and fold structures (OGS 1988a, b). Coloured versions of the total intensity magnetic data were produced to enhance subtle geological and structural features in the area. Coloured images of the calculated second vertical derivative and directionally filtered second vertical derivative magnetic data were consulted and formed a valuable part of the interpretation of the geological features in the map area (Barlow 1988b, c). These data were manipulated with respect to inclination and declination of the "sun" angle to enhance subtle features and to provide maximum use of the data.

Once collected, all the data were compiled and synthesized. Inevitably, the various bits of information presented some conflicts and contradictions. In order to resolve these problems the data was interpreted as a "best fit" from all sources. This type of holistic approach was the major guide in preparation of the maps and this report.

Acknowledgements

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General Geology

Tully and Little townships are underlain by Neoarchean supracrustal rocks of the Abitibi Subprovince of the Canadian Shield. Ultramafic, mafic, intermediate and felsic metavolcanic rocks, chemical and clastic metasedimentary rocks were intruded by ultramafic, mafic and felsic plutonic rocks and by Neoarchean to Paleoproterozoic diabase dikes (Table 1, Figure 2).

The supracrustal rocks were subdivided into rock packages based on composition, morphology and geographic distribution. The subdivisions were correlated with lithostratigraphic assemblages using the terminology proposed by Jackson and Fyon (1991). An "assemblage" is defined as consisting of stratified volcanic and/or sedimentary rock units built during a discrete interval of time in a common depositional or volcanic setting. An assemblage is typically bounded by faults, unconformities or intrusions (Thurston 1991).

Neoarchean rocks in the map area are subdivided into three assemblages (Figure 3) composed predominantly of metavolcanic rocks and one assemblage composed predominantly of metasedimentary rocks. The Kidd–Munro assemblage underlies the western and southern parts of the map area and is in fault contact with the Duff–Coulson–Rand assemblage which underlies much of the central part of the map area. The Duff–Coulson–Rand assemblage appears to be in conformable contact with the Stoughton–Roquemaure assemblage in the northeastern part of Little Township; however, the exact nature of the contact was not determined in the field. (Figure 3). The Hoyle assemblage underlies the southwestern part of Tully Township. Its contact with the Kidd–Munro assemblage is both stratigraphic and structural in the map area.

The Kidd–Munro assemblage is composed predominantly of mafic and ultramafic metavolcanic rocks with minor felsic flows and pyroclastic rocks in the map area. Metasedimentary rocks are rare and generally confined to narrow interflow units. Reversals in younging directions determined by flow features and grain gradation indicate folding about west- to northwest-trending axes. Corfu (1993) indicated that U/Pb age dates of approximately 2717 Ma were obtained from zircons contained in felsic metavolcanic rocks of the Kidd–Munro assemblage in the Kidd–Creek mine area. More recent dating (Heather et al. 1995) indicate that the upper part of the felsic metavolcanic stratigraphy is 2710 Ma and is at least 5 to 7 Ma younger than the lower part of the felsic pile.

The Kidd–Munro assemblage is geophysically characterized by diverse airborne magnetic

and electromagnetic patterns. The second vertical derivative manipulation of the magnetic data (Barlow 1988b, c) shows alternating highs and lows with the magnetic highs generally coincident with ultramafic metavolcanic and intrusive rock units and the magnetic lows generally coincident with mafic and less commonly felsic metavolcanic rock units. All rock units are generally east-northeast-trending in the western part of the assemblage, become more easterly trending in the southern part of Tully Township and are locally northwest-trending near the contact with the Duff–Coulson–Rand assemblage. Magnetic patterns appear to define east-closing regional scale folds in Tully Township; however, there are many stratigraphy parallel and crosscutting faults in this area such that transposition of stratigraphy is also possible. The pattern of airborne electromagnetic conductors (OGS 1988a, b) is generally parallel with the magnetic data and drill data indicates that many of the conductors are coincident with graphitic argillite at the contacts between major rock units. The conductor pattern is disrupted by numerous transcurrent faults and there is a profound change from east-northeast-trending conductors to northwest-trending conductors across a northwest-trending fault in northwestern Tully Township (Map P.3351, back pocket). This fault marks the contact between the Kidd–Munro and Duff–Coulson–Rand assemblages and similar northwest-trending stratigraphy parallel faults in central Tully Township are interpreted as thrust planes.

The Duff–Coulson–Rand assemblage is composed of intermediate and felsic, epiclastic and pyroclastic metavolcanic rocks. Clastic and chemical metasedimentary rocks comprise about 15% and are most abundant in the southwestern part of the assemblage. The intermediate metavolcanic rocks are distinctly pyroxene and plagioclase phenocrystic which is inferred to reflect calc-alkalic geochemistry. Jackson and Fyon (1991) indicated that the assemblage was divisible into three principal units: the Rand unit composed of calc-alkalic metavolcanic rocks, the Coulson unit composed of clastic metasedimentary rocks and the Duff unit composed of felsic metavolcanic rocks. All three units appear to be present in the map area. Corfu (1993) indicated a U/Pb zircon age date of approximately 2713 Ma for felsic metavolcanic rocks east of the map area.

Airborne magnetic data (OGS 1988a, b; Barlow 1988a, b, c) indicate that the Duff–Coulson–Rand assemblage is composed of low susceptibility magnetic units. Northwest-trending magnetic highs in northern and eastern Tully Township are correlated with lean magnetite-jasper iron formation; however, much of the intermediate and felsic metavolcanic rocks display characteristically low magnetism. The cause of several discontinuous northwest-trending magnetic high anomalies in the central and northern part of Little Township are unknown; however, mafic metavolcanic rocks or dikes are the inferred cause. The Duff–Coulson–Rand assemblage is characterized by low electromagnetic conductivity as there are few strong electromagnetic conductors (OGS 1988a, b). The few that have been drill tested are coincident with graphitic argillite at the contacts between metasedimentary and intermediate metavolcanic units. Several weak electromagnetic conductors were interpreted to be caused by conductive overburden and several other conductors are unexplained (OGS 1988a, b).

The Stoughton–Roquemaure assemblage is composed predominantly of mafic metavolcanic flows, flow breccia, tuff and lapilli tuff; felsic flows, autoclastic and pyroclastic

fragmental rocks are minor as are ultramafic metavolcanic and intrusive rocks. The Stoughton–Roquemaure assemblage is well exposed east of the map area where it has been better described and dated at approximately 2714 Ma (Jackson and Fyon 1991; Corfu 1993).

Mafic and felsic metavolcanic rock units display relatively low magnetic relief when compared to the ultramafic rocks in the Stoughton–Roquemaure assemblage (Barlow 1988a, b, c). Magnetic and electromagnetic patterns indicate northwest-trending stratigraphy with most of the ultramafic rocks north and east of the map area (Barlow 1988a, b, c).

The Hoyle assemblage comprises less than 5% of the map area and is composed predominantly of fine-grained, turbiditic clastic metasedimentary rocks with minor graphitic argillite and conglomerate. Most of the assemblage lies to the south where clastic metasedimentary rocks are coarser-grained, more thickly bedded and felsic tuff and conglomerate are locally abundant (Berger 1992, 1994, 1999). Recent work indicates a detrital zircon U/Pb age of 2699 Ma for the structural footwall metasedimentary rocks correlated with the Hoyle assemblage at the Kidd Creek mine (Heather et al. 1995); however, the author believes more work is required to adequately constrain the age of the main part of the assemblage.

Regional airborne patterns indicate low magnetic relief for most of the Hoyle assemblage (Barlow 1988a, b, c). Southeast of the map area, stratigraphy and fold axes are easterly trending; whereas, southwest of the map area northwest- and northeast-trending fold axes occur in distinctly different structural domains (Berger 1994, 1999). Linear magnetic highs are coincident with north- to northwest-trending diabase dikes. Ultramafic and mafic metavolcanic rocks are coincident with airborne magnetic highs in Murphy and Wark townships (Berger, 1999). The assemblage is characterized by weak conductivity except along the contacts with other assemblages where graphitic argillite units are correlated with long linear "trains" of strong electromagnetic conductors.

NEOARCHEAN

Ultramafic Metavolcanic Rocks

Ultramafic metavolcanic rocks occur throughout the Kidd–Munro and Stoughton–Roquemaure assemblages as massive, spinifex-, and polysutured-textured flows, flow breccia, basaltic komatiitic flows and derived schist. Graphite breccia and variolitic varieties of ultramafic flows are locally present. The major macroscopic and microscopic features of ultramafic metavolcanic rocks are outlined in Table 2.

Ultramafic metavolcanic rocks that occur in the Kidd–Munro assemblage are predominantly composed of spinifex- and polysutured-textured flows; flow breccia including graphite breccia is common. Individual flows are generally less than 3 m thick and commonly occur as stacked flow units with spinifex-textured bases and brecciated flow tops. Pyroxene spinifex is most common in the thinner flows and primary pyroxene is locally preserved. Olivine

spinifex is less common and is more likely to occur within the thicker accumulations of ultramafic rocks in the southern part of Tully Township. In several places in the western and southwestern parts of Tully Township the flows are intercalated with clastic and graphitic metasedimentary rocks. Where this occurs clastic material, graphite and less commonly pyrite is incorporated into the ultramafic rocks imparting a brecciated appearance which the author has described as "graphite breccia". Diamond drill core from a hole in Lot 8, Concession III, Tully Township, sunk by Noranda Exploration Company Limited (TI-1029, Timmins Drill Core Library) displays the ultramafic-metasedimentary contact relationship very well and indicates that ultramafic volcanism in this part of the Kidd–Munro assemblage was coeval with sedimentation. Similar types of ultramafic flows described as overbank levee flows occur at Kambalda, Australia (Hill et al. 1990). Komatiitic nickel-copper deposits occur where the ultramafic flows are channelized (Lesher and Arndt 1990; Hill et al. 1990).

Massive cumulate ultramafic rocks are most common in the southern part of Tully Township where they are associated with thick accumulations of stacked flows and related ultramafic sills and stocks. The cumulate rocks are composed of black, dark green and green, fine- to medium-grained peridotite and less commonly pyroxenite which are generally featureless in hand sample. In thin section these rocks are characterized by adcumulate, mesocumulate and orthocumulate textures with interstitial material composed of fine spinifex-textured pyroxene, massive amphibole, talc and serpentine. In a few thin sections, oval patches of chlorite and/or serpentine are interpreted to represent amygdules which supports the premise that the cumulate rocks are members of flow units. It is possible that these rocks represent the channelized portions of the spinifex-textured flows described above. In several places graphitic wacke and metasedimentary schist are interbedded between cumulate flows and these rock types account for many of the airborne electromagnetic anomalies in the southern part of Tully Township (OGS 1988a). Strong to intense high aeromagnetic patterns characterize the cumulate ultramafic rocks; however, magnetite accounts for less than 10% of the mineralogy in all thin sections examined (Table 2).

Ultramafic metavolcanic rocks of the Stoughton–Roquemaure assemblage occur in the northeastern part of Little Township. They are composed mainly of massive, cumulate flows that are mineralogically similar to ultramafic flows in the Kidd–Munro assemblage. The flows are thin, discontinuous and interbedded with massive, pillowed and variolitic mafic metavolcanic rocks. The ultramafic flows are interpreted by the author to be part of a much larger ultramafic complex which extends north and east of the map area (Barlow 1988a, b).

Basaltic komatiitic rocks are dark green to pale green, non-magnetic and generally massive. These rocks are spatially associated with spinifex- and cumulate-textured ultramafic flows and less commonly associated with variolitic mafic metavolcanic rocks. In thin section these rocks are plagioclase- and amphibole-bearing which distinguishes them from their more ultramafic counterparts. It is probable that basaltic komatiite flows are more numerous than portrayed on Map P.3351 (back pocket) as these rocks are difficult to distinguish from magnesium tholeiitic basalts that occur in the map area. The association with spinifex- and cumulate-textured ultramafic flows is the most valid way to recognize these rocks in the absence

of whole rock geochemistry.

Ultramafic schist is a strongly foliated carbonate-chlorite-talc-bearing rock that retains little, if any, primary features. This rock type is most commonly found where faults and shear zones cut ultramafic rocks; however, schist also occurs in areas affected by hydrothermal alteration. Ultramafic schist is common at contacts between ultramafic rocks and other rock types, especially in the vicinity of the Nickel Offsets gold deposit in southwestern Tully Township. Ultramafic schist is also common in the structural footwall of the Frankfield and Intex gold deposits in the west central part of Tully Township. Schist produced solely by shearing is characterized by carbonate, talc and chlorite; whereas, white mica and quartz are characteristic additions to hydrothermally altered ultramafic schist. The principal occurrences of hydrothermally altered ultramafic schist are at the Nickel Offsets gold deposit and the gold occurrences explored by Homestake Canada Incorporated in lots 6 and 7, Concession IV, Tully Township.

Flow morphology, grain gradation and load casts in interflow metasedimentary units indicate that the ultramafic rocks are synclinally folded in the southern part of Tully Township. However, inferred faulting and lack of exposure does not permit a detailed description of the fold geometry. Local facing reversals obtained in diamond drill core indicate that the ultramafic metavolcanic rocks are both younger and older than clastic metasedimentary and mafic metavolcanic rocks in the same area. This is interpreted to indicate than ultramafic volcanism was coeval with mafic volcanism and sedimentation.

Mafic Metavolcanic Rocks

Mafic metavolcanic rocks comprise most of the Kidd–Munro and Stoughton–Roquemaure assemblages. The Kidd–Munro assemblage is composed of pillowed and massive flows with subordinate pillow and flow top breccia. Tuff, variolitic and amygdaloidal rocks are minor. Leucoxene-bearing mafic metavolcanic rocks have been designated on Map P.3351 (back pocket, unit 2k) because some industry geologists believe this mineral is spatially related to gold mineralization. Graphite breccia (Map P.3351, back pocket, unit 2j) is composed of angular mafic metavolcanic clasts in a graphite-, chlorite- and carbonate-bearing matrix and is more fully described below.

Mafic metavolcanic rocks of the Stoughton–Roquemaure assemblage are composed of predominantly pillowed and massive flows. Pillow breccia, hyaloclastite, tuff and lapilli tuff are common and are locally the dominant rock types. Graphite breccia, variolitic flows and mafic tuff are minor. Table 3 summarizes the macroscopic and microscopic features of the mafic metavolcanic rocks.

KIDD–MUNRO ASSEMBLAGE

Amygdaloidal pillowed and massive mafic metavolcanic flows are exposed in the southern part

of Little Township. These rocks are brown to dark to orange-brown weathering and are dark green on fresh surface. Pillowed flows are most common and pillows are generally small (up to 60 by 30 cm), close packed and poorly formed with selvedges varying between 0.5 to 2 cm thick. Chlorite and carbonate filled amygdules up to 1 mm in diameter comprise less than 10% of the flows and the minor interpillow material is composed of hyaloclastite. Massive flows in the same area are generally fine-grained rocks that are interlayered with the pillowed flows. Massive and pillowed flows are generally less than 10 m thick which the author interprets to represent deposition in a distal environment (cf. Easton and Johns 1986). These mafic rocks extend into the northern part of Evelyn Township and are exposed on the northwest shore of Frederick House Lake (Berger 1994). In northern Evelyn Township mafic dikes interpreted to be feeders into the mafic pile are exposed.

Massive, phaneritic flows, pillowed flows and mafic schist are exposed immediately north of the Intex gold deposit in Lot 12, Concession III, Tully Township. The phaneritic flows trend between 055° and 075°, and are steeply north dipping. They are magnetic, leucoxene-bearing and also occur in diamond drill holes as the structural hanging wall of the Intex gold deposit. Green to dark green pleochroic amphibole and primary plagioclase (An_{32-38}) are the most abundant minerals observed in thin section: however, biotite is present in minor quantities which is inferred to indicate that potassic alteration has affected the rocks in the vicinity of the gold deposit. Pillowed flows that occur north of the massive flows are characterized by close packed, well formed pillows up to 1 m by 0.5 m in size and are southward-younging. Minor pillow breccia and hyaloclastite occur between flows and as interpillow material. Weak pervasive carbonate alteration occurs throughout the rocks and tends to lighten the weathered and fresh surfaces.

Variolitic mafic metavolcanic rocks are minor in the Kidd–Munro assemblage and are most closely spatially associated with ultramafic metavolcanic rocks. White plagioclase varioles up to 5 mm in diameter and comprising up to 25% of the rock are most abundant in the central part of Tully Township in the vicinity of the gold occurrence discovered by Hollinger Mines Limited in 1973 (*see* Economic Geology). Variolitic mafic flows occur in minor abundance east of the Nickel Offsets gold deposit and at the Frankfield gold deposit.

Plagioclase-rich mafic flows are characterized by 30 to 50% plagioclase content as phenocrysts and in the groundmass; however, the colour index is greater than 50 because much of the plagioclase is saussuritized. Some of these rocks resemble foliated phaneritic mafic flows observed at the Intex Gold Deposit and other rocks resemble intermediate metavolcanic rocks described below. The plagioclase-rich rocks are most abundant in a 3.5 km wide area west of the Buskegau River Fault and east of Tully–Prosser township boundary which is characterized by many northwest-trending shear zones and faults. It is probable that mafic and intermediate metavolcanic rocks are structurally interlayered in this area which accounts for the distribution of the plagioclase-rich rocks.

Mafic pyroclastic tuff is rare in the Kidd–Munro assemblage and occurs interbedded with narrow discontinuous graphitic wacke units in southeastern Tully Township. The tuff is dark

green and has a distinct granular texture composed of closely packed, rounded grains of mafic metavolcanic rock. Tuff units are narrow (less than 3 m thick), discontinuous and are not as abundant as described in diamond drill logs. In parts of the Kidd–Munro assemblage where there is pronounced structural deformation rocks described in diamond drill logs as "mafic tuff" were observed by the author to be strongly foliated and more properly described as schist (see below). Jackson and Fyon (1991) indicated that mafic pyroclastic rocks are not abundant in the assemblage.

Mafic graphite breccia is a rock type characterized by angular fragments of mafic flow in a graphite ± chlorite ± carbonate-bearing matrix. In a few places disseminated pyrite, pyrrhotite and rarely chalcopyrite comprise up to 25% of the matrix material. This rock type is widely distributed throughout the Kidd–Munro assemblage and occurs in two prominent environments. Graphite breccia is developed at the base or top of many mafic flows as narrow, widely spaced graphite-chlorite stringers that become more densely distributed as the flow contact is approached. The stringers become interconnected and wider creating an "in situ" monolithic breccia with large fragments ($\geq$30 cm) which can be readily fitted together. In some flows the brecciation shows no further progress. However, in many flows brecciation increases toward the contact to the point where the abundance of matrix becomes greater than fragments and fragment size averages 1 cm or less in size. The matrix is very conductive and this rock type is responsible for many of the airborne conductors in Tully and Little townships (OGS 1988a, b). In a few drill holes, the graphite breccia passes conformably into graphitic mudstone, siltstone and rarely wacke. This indicates to the author that development of the breccia is primary and probably related to hydro-fracturing of the flow in a subaqueous environment. This type of graphite breccia is common in Wark Township, southwest of the map area (Berger 1999).

Graphite breccia is very common adjacent to and within faults. In this environment graphite and chlorite stringers occur along, as well as crosscutting foliation planes. Carbonate is not as abundant as in the primary environment described above and brecciation commonly crosses contacts between different rock types. Graphite breccia in this environment is inferred to be tectonically derived with graphite, chlorite and less commonly sulphides remobilized into the fault planes. Much of the graphite breccia in the central part of Tully Township is inferred by the author to be tectonically derived and many airborne electromagnetic conductors mark the location of graphite breccia coincident with faults in this area.

Mafic schist is a descriptive term used to describe dark green to black, strongly foliated rock which may have been derived from a mafic metavolcanic protolith or from some other protolith that was subsequently altered. Unaltered schist derived from a mafic metavolcanic protolith is characterized by chlorite, carbonate, epidote and opaque minerals and is commonly transitional into the less foliated parent rock. This type of mafic schist is most common in faults and shear zones throughout the Kidd–Munro assemblage. Hydrothermally altered schist derived from a mafic metavolcanic protolith is commonly strongly foliated and composed of carbonate, chlorite, white mica and quartz. Graphite commonly occurs along foliation planes and accounts for the dark colour of the schist. This type of schist is exposed in a narrow shear zone at the Intex gold deposit in Tully Township.

Mafic schist composed mainly of chlorite, carbonate, graphite and sulphide minerals is host to most of the gold mineralization at the Nickel Offsets gold deposit. Although mafic metavolcanic rocks were the major protolith for this schist ultramafic metavolcanic, clastic metasedimentary and felsic porphyritic rocks were determined in thin sections to make up part of the schist. There is a strong foliation in the schist and hydrothermal alteration characterized by white mica, quartz, tourmaline and lesser amounts of biotite and sulphides has affected much of the ore zone. This type of mafic schist also occurs in the vicinity of the Hollinger gold occurrence in central Tully Township where hydrothermal alteration occurs along the contacts between metavolcanic and metasedimentary rocks.

The distribution of the mafic metavolcanic rocks of the Kidd–Munro assemblage presented on Map P.3351 (back pocket) is based upon the location of outcrop, drill data and the interpretation of the total field and vertical derivative magnetic data (OGS 1988a, b; Barlow 1988a, b, c). Mafic units generally display lower magnetic relief than ultramafic rocks in Tully Township; however, magnetite-bearing phaneritic mafic flows occur northwest of the Intex gold deposit and may be present elsewhere in the Kidd–Munro assemblage. Diamond drill data is sufficiently dense to accurately delineate between the major mafic metavolcanic and metasedimentary units in the Kidd–Munro assemblage; however, numerous narrow interflow metasedimentary units could not be separated from the mafic metavolcanic rocks (Map P.3351, back pocket). Stratigraphic facings of pillows, flow top brecciation and graded bedding in interflow metasedimentary units indicate the mafic metavolcanic rocks are generally south- to southwest-younging in the southern part of the map area. Facing reversals, based primarily upon stratigraphic younging in interflow metasedimentary units, occur in the central part of Tully Township and indicate folding about northwest-trending axes in this area.

STOUGHTON–ROQUEMAURE ASSEMBLAGE

Mafic metavolcanic rocks in the Stoughton–Roquemaure assemblage are known only from drill core in the map area and are composed predominantly of massive and pillowed flows with subordinate tuff, flow and pillow breccia. Variolitic flows are common; graphite breccia is minor.

Massive mafic flows are most common and are generally fine-grained, green to dark green and non-magnetic. Phaneritic and leucoxene-bearing flows are minor . Pillowed mafic flows are common and tend to be more abundant near the contact with felsic metavolcanic rocks in the southwest part of the assemblage. Pillowed flows tend to be variolitic with 2 to 5 mm white, rounded plagioclase varioles comprising less than 25% of the rock. Pillow shapes appear to be well formed with 0.5 to 2 cm thick selvedges and minor to moderate amounts of interpillow hyaloclastite.

Mafic pyroclastic and epiclastic tuff, lapilli tuff, hyaloclastite, and flow breccia are green to dark green, fine- to medium-grained rocks that display a distinct fragmental texture. Fragments vary from less than 1 mm in tuff to over 8 cm in flow breccia and are composed predominantly

of mafic metavolcanic rock and lesser amounts of feldspar grains. These rocks commonly occur as discontinuous interflow units that vary from less than 2 m to over 50 m in thickness. Tuff and lapilli tuff tend to be more abundant near the southwest contact with felsic metavolcanic rocks; whereas, hyaloclastite and flow breccia occur throughout the mafic metavolcanic rocks. Tuff and lapilli tuff are generally massive, ungraded, poorly sorted rocks and are commonly interbedded with graphitic argillite, felsic and mafic metavolcanic rocks. Hyaloclastite commonly occurs as interpillow material and less commonly occurs as narrow units interbedded between mafic flows. Flow breccia commonly occurs at the top of massive and pillowed flows as narrow discontinuous units up to a few metres thick.

Mafic graphite breccia is similar to that described in the Kidd–Munro assemblage and appears to be most closely associated with primary hydrofracturing described above. Graphite breccia most commonly occurs at the contact between mafic and felsic metavolcanic rocks with minor intercalation of graphitic argillite and clastic metasedimentary material. A few isolated and discontinuous airborne electromagnetic conductors (OGS 1988b) are coincident with graphite breccia occurrences.

Mafic schist occurs in only a few areas within the Stoughton–Roquemaure assemblage and is mineralogically similar to mafic schist in the Kidd–Munro assemblage. Hydrothermally altered schist is localized in narrow discontinuous zones at the contacts between mafic and ultramafic rocks in the very northeastern part of Little Township. The paucity of schist is interpreted to be correlated with the lack of extensive faulting and shearing in the Stoughton–Roquemaure assemblage.

Intermediate Metavolcanic Rocks

Intermediate metavolcanic rocks, correlated with the Duff–Coulson–Rand assemblage (Jackson and Fyon 1991) are inferred to underlie approximately 35% of the map area, mainly in the central part of Little and the northeastern part of Tully Township. These rocks are commonly porphyritic; characteristically plagioclase and pyroxene. The intermediate rocks are marked by distinctly low magnetic relief and there is very low conductivity in the rocks as displayed by the lack of strong airborne electromagnetic conductors (OGS 1988a, b).

Narrow discontinuous units of intermediate metavolcanic rocks are structurally interleaved within the Kidd–Munro assemblage in the central part of Tully Township; however, most reported occurrences of "andesite" and "intermediate tuff" in this assemblage proved to be carbonate altered mafic metavolcanic rocks where observed by the author. Table 4 summarizes the macroscopic and microscopic features of the intermediate metavolcanic rocks.

Intermediate pyroclastic rocks of the Duff–Coulson–Rand assemblage are exposed in a large outcrop area in Lot 7, Concession V, Little Township. The brown to grey weathering outcrops are composed of tuff breccia, lapilli tuff and crosscutting mafic dikes. The tuff breccia is heterolithic with subangular to rounded clasts up to 25 cm (avg. 8 to 10 cm) composed of

pyroxene and plagioclase phenocrystic mafic and intermediate metavolcanic clasts, rare felsic metavolcanic clasts and a few scoriaceous and pumiceous clasts. The pyroclastic rocks are commonly clast supported in a crystal-lithic intermediate tuff matrix. In thin section fresh, euhedral clinopyroxene phenocrysts commonly display simple twinning (optically determined to be augite), and symplectic intergrowth of pyroxene and quartz (Photo 1). Pyroxene phenocrysts vary between 1 and 5 mm and comprise up to 20% of the clasts. Euhedral plagioclase laths are largely altered to epidote and carbonate, vary between 2 and 7 mm and may comprise up to 30% of the clasts. Euhedral olivine phenocrysts were observed in one clast. The tuff breccia deposits are poorly sorted, unstratified and ungraded. Locally, lapilli tuff (avg. clast size 1 cm) composed of monolithic pyroxene phenocrystic mafic clasts was observed. Several of the clasts contain carbonate and chlorite filled gas cavities up to 1 cm in diameter and in thin section many clasts display minute chlorite filled vesicles. Locally, intermediate, pyroxene phenocrystic dikes (60 cm wide by 20 m long) of similar composition to some of the clasts were observed intruded into the pyroclastic rocks. These features are interpreted to indicate pyroclastic deposition in a proximal, shallow water to subaerial volcanic environment that underwent only minor reworking.

Epiclastic tuff breccia, tuff and interbedded wacke are exposed in outcrops along the Frederick House River, north of the High Falls dam (Map P.3351, back pocket). Pink and white tonalitic dikes intruded these outcrops and patchy, pervasive iron carbonate alteration occurs in the matrix and more scoriaceous fragments. Heterolithic tuff breccia occurs as well stratified, poorly sorted and crudely graded beds from 30 to 100 cm thick that are interbedded with lapillistone and wacke beds of comparable thickness. Subangular to rounded clasts up to 60 cm in size are composed of trachytic-textured, plagioclase-phenocrystic intermediate flows, scoriaceous aphanitic mafic flows, and pyroxene- and plagioclase-phenocrystic intermediate and mafic flows; metasedimentary clasts are minor. Some of the aphanitic clasts display aerodynamic shaping and reaction rims which are interpreted to represent airfall tephra that was incorporated into the deposits (Photo 2). Lapillistone deposits containing clasts of similar composition are less common than the tuff breccia and indicate greater reworking of the metavolcanic material. The wacke beds are composed mainly of fine-grained intermediate tuff with minor siltstone. Grain gradation, ball and pillow structure, small scale scours and load casts are common primary features in the wacke and provide reliable stratigraphic younging directions which are consistently southwest. These deposits are interpreted to represent substantial reworking of intermediate to mafic metavolcanic rocks in a vigorous subaqueous environment medial to distal from the magma source.

Plagioclase- and pyroxene-phenocrystic rocks that were observed and reported in diamond drill holes in concessions II and III, Little Township and concessions III, IV and VI, Tully Township define the southwestern limit of intermediate rocks in the Duff–Coulson–Rand assemblage. These rocks are morphologically similar to the rocks described above; however, flows appear to be more abundant. Jackson and Fyon (1991) indicated that the intermediate rocks of the Duff–Coulson–Rand assemblage are calc-alkalic and their rock descriptions closely match those in the map area.

Intermediate rocks within the Kidd–Munro assemblage are characterized by a colour

index of 40 or less and are commonly amygdaloidal. Lath-like plagioclase phenocrysts were observed in a few drill holes and locally dioritic rocks were observed. Intermediate rocks occur most commonly within a few hundred metres of the inferred contact between the Duff–Coulson–Rand and Kidd–Munro assemblages and there is commonly pronounced shearing or faulting in close proximity to these rocks. The author infers that these intermediate rocks are tectonically interleaved members of the Duff–Coulson–Rand assemblage and are not chemically or morphologically part of the Kidd–Munro assemblage.

Felsic Metavolcanic Rocks

Felsic metavolcanic rocks occur in three assemblages in the map area and are composed of massive and laminated flows, flow breccia and hyaloclastite, pyroclastic tuff, lapilli tuff and tuff breccia. Felsic schist, graphite breccia and spherulitic varieties are subordinate. Table 5 summarizes the macroscopic and microscopic features of the felsic metavolcanic rocks.

KIDD–MUNRO ASSEMBLAGE

Felsic metavolcanic rocks comprise approximately 5% of the assemblage and are composed mainly of massive flows and flow breccia. These rocks are known only from drill data where they are described as white, quartz porphyritic rocks that may also contain plagioclase phenocrysts. Spherulites are reported from a few drill holes and in one thin section from drill core in Lot 8, Concession V, Tully Township, perlitic cracks indicative of devitrification were observed in spherules (Photo 3). The felsic rocks occur in units no greater than 200 m thick and appear to be discontinuous along strike (lengths up to 1 km). The author infers that the felsic volcanism was minor in the map area and that the major felsic centres occur to the west in the Kidd Creek area. Approximately 1 km west of Tully Township, quartz-porphyritic flows and pyroclastic tuff breccia are exposed in Prosser Township. These white weathering rocks are similar to those described in lots 11, 12, Concession IV in the map area and are inferred by the author to be contiguous. The felsic rocks in Prosser Township are FIII rhyolites by the classification scheme of Lesher et al. (1986) (D. Brisbin, Falconbridge Limited, Timmins, personal communication, 1995) and the felsic rocks in Tully Township are inferred to be FIII rhyolites as well.

DUFF–COULSON–RAND ASSEMBLAGE

Felsic metavolcanic rocks comprise approximately 15 to 20% of the Duff–Coulson–Rand assemblage and underlie northeastern and northwestern parts of Tully Township. Massive felsic flows occur in drill data from lots 11, 12, Concession V, Little Township. In thin section this rock is microporphyritic with plagioclase and quartz phenocrysts in quartz-rich cryptocrystalline groundmass. The rhyolite is pervasively hematized (Photo 4) as a result of a nearby north-striking fault which is interpreted to terminate the eastward extension of the felsic rocks (Map P.3351, back pocket). The contacts of the felsic rocks are interpreted to occur along weak northwest-trending airborne electromagnetic conductors (OGS 1988a, b) and a total thickness of 900 m is

inferred. The felsic rocks continue northwest into Duff Township and future mapping should reveal the extent and nature of the rocks in this area.

Felsic metavolcanic flows, flow breccia, pyroclastic breccia and graphite breccia that underlie the northwestern part of Tully Township are correlated with the Duff–Coulson–Rand assemblage. The flows are known from drill data to be chalky white, aphanitic and massive to flow laminated. These rocks are characterized by cryptocrystalline to fine-grained quartz and plagioclase with less than 20% chlorite, epidote and opaque minerals. Carbonate is widespread and abundant (15 to 35%); whereas, white mica generally comprises less than 20% of the rock. Quartz and plagioclase phenocrysts are rare, in contrast to felsic metavolcanic rocks in the Kidd–Munro assemblage. Whole rock geochemistry included on some diamond drill logs indicate that the flows in Lot 9, Concession V, Tully Township are predominantly calc-alkalic with between 64 and 70% SiO_2, generally high LOI (greater than 3%) and many of the samples contain high Na_2O (greater than 5%) which indicates albitization.

Felsic flow breccia and hyaloclastite are common and are composed of monolithic rounded to angular fragments (< 1 mm to 8 cm) with felsic tuff or glass matrix. Net vein silica and less commonly chlorite delimit the fragments in some deposits and spherulites were observed locally. These rocks have a similar composition to and are commonly intermixed with the massive flows.

Felsic pyroclastic rocks composed predominantly of tuff, lapilli tuff and minor tuff breccia are not common but tend to be most abundant near the contacts of the felsic flows, clastic and graphitic metasedimentary rocks and mafic metavolcanic rocks (Map P.3351, back pocket). The pyroclastic rocks comprise narrow, discontinuous units composed of monolithic felsic metavolcanic fragments of similar composition to the flows described above. Rare, massive, tuff and lapilli tuff units with stretched wispy pumice fragments are interbedded with clastic metasedimentary rocks immediately overlying the felsic flows. These fragmental rocks appear to be of local derivation and long distance transport is not indicated.

Felsic graphite breccia is common near the contact with the Kidd–Munro assemblage and is characterized by black graphite and chlorite stringers that form a stockwork in felsic flows. Graphite breccia is most abundant in the vicinity of northeast-trending faults that crosscut the metasedimentary–felsic metavolcanic rock contact and is well displayed in drill core from Lot 8, Concession V, Tully Township (stored at Timmins Drill Core Library). The proximity of the breccia to faults indicates that the felsic graphite breccia in this part of the Duff–Coulson–Rand assemblage is tectonic in origin. Farther northwest in Lot 9, Concession V, felsic graphite breccia occurs stratigraphically below graphite metasedimentary rocks and in this area the breccia is inferred to be primary and graphitic metasedimentary material was mechanically incorporated into felsic flow breccia. As with graphite breccia of the other rock types several coincident airborne electromagnetic conductors were detected by the government geophysical survey (OGS 1988a).

Felsic schist is pale yellow, strongly foliated, quartz- and sericite-bearing. It is most

common in the vicinity of the Buskegau River Fault but occurs elsewhere as narrow discontinuous units near the contact with the Kidd–Munro assemblage. Schist marks the locus of faulting and shearing and its presence was used to infer the location of faults on Map P.3351 (back pocket).

STOUGHTON–ROQUEMAURE ASSEMBLAGE

Felsic metavolcanic rocks comprise approximately 25% of the Stoughton–Roquemaure assemblage and are composed predominantly of pyroclastic tuff, lapilli tuff and tuff breccia. Laminated flows, flow breccia and spherulitic flows are subordinate. The felsic rocks form a 500 m thick northwest-trending continuous unit at the contact between the Stoughton–Roquemaure and Duff–Coulson–Rand assemblages. Narrower, discontinuous felsic units were mapped within the Stoughton–Roquemaure assemblage (Map P.3351, back pocket).

The pyroclastic rocks are heterolithic to monolithic with quartz-feldspar porphyry clasts dominant, aphanitic rhyolitic clasts subordinate, mafic metavolcanic and graphitic metasedimentary clasts rare. These rocks are poorly sorted, ungraded and interbedded with autobrecciated felsic flows, clastic and graphitic metasedimentary rocks. In most drill data the fragmental rocks appear to be locally derived having undergone only minimal transport. The pyroclastic deposits are thickest and most extensive at the contact with the Duff–Coulson–Rand assemblage.

Felsic flows in the Stoughton–Roquemaure assemblage are white to pale yellow, quartz and feldspar phenocrystic, flow laminated with autobrecciation common. In thin section these rocks are quartz-rich and generally contain more white mica than either the Kidd–Munro or the Duff–Coulson–Rand felsic metavolcanic rocks. Spherulitic flows are common and in thin section perlitic cracks were observed indicative of devitrification. In general felsic flows occur stratigraphically lower than the pyroclastic rocks described above; however, in a couple of drill holes, felsic flows were intercalated with plagioclase phenocrystic intermediate flows similar in composition to those described in the Duff–Coulson–Rand assemblage (see above). Quartz-feldspar porphyry sills occurred in the same drill holes and this indicates the contact between the two assemblages is structurally and morphologically complex.

Metasedimentary Rocks

Metasedimentary rocks composed predominantly of wacke, siltstone and graphitic mudstone occur in all the assemblages in the map area. Chemical metasedimentary rocks composed of chert, sulphide- and oxide-facies ironstone occur only in the Kidd–Munro and Duff–Coulson–Rand assemblages. Approximately 10 to 15% of the map area is underlain by metasedimentary rocks.

KIDD–MUNRO ASSEMBLAGE

Clastic and chemical metasedimentary rocks composed predominantly of graphitic and pyritic mudstone and less commonly wacke comprise less than 5% of the Kidd–Munro assemblage and most commonly occur as narrow discontinuous units between metavolcanic flows. Northwest-trending units up to 400 m thick occur in northwest Tully Township where wacke and graphitic mudstone display grain gradation, load casts and rarely ball and pillow structures indicative of turbidites (cf. Walker 1992). These metasedimentary rocks are fine-grained and appear to have been deposited in a quiet water (below storm wave base), distal environment. They are interbedded with felsic tuff and mafic flows indicative of coeval volcanism in this part of the assemblage.

Wacke and mudstone comprise a 700 m wide, northwest-trending unit in southwest Little and southeast Tully townships. This unit is reported in only a few drill data and is poorly constrained by geophysical data. Mafic metavolcanic rocks more clearly correlated with the Kidd–Munro assemblage occur on either contact; however, it is possible that the metasedimentary rocks are tectonically interleaved and more properly part of the Duff–Coulson–Rand assemblage.

Chemical metasedimentary rocks composed of chert and pyritic ironstone containing lesser amounts of sphalerite and chalcopyrite occur in units up to 5 m thick in the central part of Tully Township and are interpreted as exhalites (Markov 1982). The chert is composed of white and black cryptocrystalline silica which is most commonly massive and rarely laminated. Disseminated and stringer pyrite with minor sphalerite and chalcopyrite are common. Pyritic ironstone is composed of 50 to 90% massive and concretionary pyrite with minor base metals in a graphitic and cherty matrix. Lydon (1988) indicated that exhalitive units commonly overlie and extend laterally away from massive sulphide deposits as a stratigraphic marker unit. Exhalite hosted copper-zinc mineralization in Lot 8, Concession IV, Tully Township may be indicative of more extensive and massive nearby base metal mineralization.

DUFF–COULSON–RAND ASSEMBLAGE

Metasedimentary rocks comprise approximately 15% of the Duff–Coulson–Rand assemblage. Fine-grained wacke, siltstone, mudstone, graphitic mudstone and rare sulphide-facies ironstone underlie the southeastern and central parts of Little Township in a wedge shaped unit that widens to the southeast into Dundonald Township (Muir 1993). The clastic rocks are thinly to thickly bedded and commonly display well preserved grain gradation and load casts indicative of turbidity current deposition. Wacke and siltstone are predominantly feldspathic commonly with greater than 35% matrix composed of fine-grained white mica and quartz. Weak to strong northwest-trending airborne electromagnetic conductors mark the northern contact of the metasedimentary rocks with intermediate metavolcanic rocks of the Duff–Coulson–Rand assemblage and are correlated with graphitic mudstone (OGS 1988b).

Laminated magnetite-jasper ironstone was encountered in diamond drill holes in Lot 7, Concession VI, Tully Town.ship. The lean iron formation occurs as multiple laminated beds up to 30 cm thick interbedded with intermediate metavolcanic flows and tuff. A pronounced northwest-trending magnetic anomaly is coincident with the iron formation and a strike length of 7 km is inferred in the map area. Iron formation is unique to the Duff–Coulson–Rand assemblage and its presence in Tully Township marks the first observed occurrence north of Timmins (35 km) by the author. Iron formation denotes a significant change in depositional environment for the Duff–Coulson–Rand assemblage relative to the Kidd–Munro, Hoyle and Tisdale assemblages farther south and west (Berger 1992, 1994, 1999). The Duff–Coulson–Rand assemblage is characterized by shallow water to subaerial volcanism and sedimentation; whereas, the other assemblages mentioned above were formed in deeper water (cf. Berger 1994, 1999). This data indicates a difference in depositional and likely the tectonic setting for the Duff–Coulson–Rand assemblage relative to the other assemblages.

STOUGHTON–ROQUEMAURE ASSEMBLAGE

Graphitic mudstone, chert and sulphide-facies ironstone form unmappable, discontinuous interflow units within the Stoughton–Roquemaure assemblage. These rocks are similar to those described in the Kidd–Munro assemblage; however, there appears to less sphalerite and chalcopyrite present in the sulphide ironstone. Felsic metavolcanic rocks are commonly associated with and are inferred to stratigraphically underlie the metasedimentary rocks. A few isolated airborne electromagnetic conductors are coincident with these types of metasedimentary rocks.

HOYLE ASSEMBLAGE

Metasedimentary rocks that occur south of an easterly trending ultramafic unit in southwest Tully Township are correlated with the Hoyle assemblage. These rocks are known from drill data in Wark and Gowan townships where they are composed of medium-grained wacke, siltstone, graphitic mudstone and interbedded felsic tuff (Berger 1992, 1999). The rocks are inferred to be turbidites deposited in a mid-fan subaqueous environment (Berger 1999).

A 800 m thick metasedimentary unit composed of fine-grained wacke, graphitic mudstone, schist and rare conglomerate occurs north of the ultramafic unit described above and is the structural hanging wall of the Nickel Offsets gold deposit. This unit extends to the southwest into Wark Township where it occurs between two mafic-ultramafic metavolcanic units correlated with the Kidd–Munro assemblage (Berger 1999). The metasedimentary rocks are mineralogically similar to but are finer-grained, more thinly bedded and contain a greater proportion of mud to sand than metasedimentary rocks farther south. These features indicate deposition in quiet water in a distal submarine fan environment (cf. Walker 1992). Schist is common in the metasedimentary rocks in the map area and is correlated with northeast-trending shear zones which may represent thrust planes. Reversals in younging directions indicate that the metasedimentary rocks are folded about northeast-trending axes and this indicates that more

detailed work is required to determine the stratigraphic position of these rocks relative to the Kidd–Munro assemblage. This package of metasedimentary rocks may represent a distal facies of the Hoyle assemblage which is tectonically interleaved within the Kidd–Munro assemblage or it may be a separate metasedimentary unit deposited between two metavolcanic members of the Kidd–Munro assemblage. The author is not certain if a detrital zircon U/Pb age date of 2699 Ma at the Kidd Creek mine was derived from this package of rocks (Bleeker et al. 1993; Heather et al. 1995); however, if so, it would indicate that the rocks are significantly younger than the Kidd–Munro assemblage (2710 to 2715 Ma) and that gold mineralization at the Nickel Offsets deposit was younger than 2699 Ma.

Ultramafic and Mafic Intrusive Rocks

Massive peridotite, pyroxenite, gabbro-diorite and related schist occurs in the Kidd–Munro and Stoughton–Roquemaure assemblages. For the most part there are no definitive field criteria to distinguish between intrusive and extrusive varieties of these rocks. Massive rocks without obvious flow features like spinifex or polysuturing have been mapped as intrusive by the author. Massive peridotite, schist and locally pyroxenite underlie parts of Lot 12, Concession II, Lot 8, Concession III in Tully Township and lots 1, 2, 3, Concession VI, Little Township. Copper and nickel mineralization is associated with the ultramafic rocks in Little Township (*see* Economic Geology).

Gabbro-diorite is a term applied to thick units of phaneritic mafic rocks devoid of obvious flow features. These rocks are generally plagioclase-rich (greater than 20% phenocrysts) and resemble phaneritic mafic flows described west of the Intex gold deposit in the Kidd–Munro assemblage (see above). Gabbro and quartz diorite occurs elsewhere in the Kidd–Munro assemblage and has been described by Berger (1994, 1999).

Felsic and Intermediate Intrusive Rocks

Felsic and intermediate intrusive rocks composed of quartz-feldspar porphyry, feldspar porphyry and tonalite occur throughout the map area as narrow dikes and intrusions that are usually too small to put on Map P.3351 (back pocket). Over 200 m of black and white feldspar porphyry was encountered in a diamond drill hole southwest of the Nickel Offsets gold deposit. Most of the porphyry has a black groundmass with white euhedral albite phenocrysts comprising 10 to 15% of the rock (Photo 5). Locally quartz phenocrysts up to 5 mm in size were observed. In thin section carbonate, biotite and opaques (mostly graphite) comprise 20% of the groundmass. White mica is minor. White porphyry comprises pods, lens and "fragments" within the black porphyry. In many places diffuse black stringers cut the white porphyry. In thin section the white porphyry is mineralogically similar to the black porphyry except that actinolite occurs in the groundmass. Biotite and white mica are restricted to the black stringers. The author infers that the white porphyry was altered by infusion of biotite and white mica and this is inferred to reflect potassic alteration of the porphyry. The black and white porphyry intruded ultramafic metavolcanic rocks as the contacts are sheared. A distinct magnetic low coincident with the porphyry indicates that it is at least 300 to 400 m in size. The economic potential of the porphyry remains largely untested.

Equigranular tonalite was observed in drill data within the Nickel Offsets gold deposit ore zone. The tonalite is strongly foliated with graphite and sulphides commonly occupying the foliation planes. In this area the tonalite resembles the groundmass of the feldspar porphyry described above and it is probable that members of the porphyry intruded prior to deformation and mineralization of the ore zone.

Quartz-feldspar porphyry was observed in a few drill data intruded into graphitic argillite near the contacts of the Duff–Coulson–Rand assemblage. The porphyry is light grey to white and contains anhedral quartz phenocrysts which are commonly embayed with the groundmass and euhedral plagioclase phenocrysts which are commonly highly altered to carbonate and white mica. The porphyry generally occurs as discreet dikes less than 2 m wide. However, a 40 m wide section of quartz-feldspar porphyry, porphyritic breccia and graphitic argillite in northeastern Little Township may represent flow lobes extruded into a sedimentary sequence.

Fine-to medium-grained tonalite occurs as dikes up to 10 m wide in outcrop and in drill data at High Falls in Little Township (Map P.3351, back pocket). The dikes are white to pink (hematized) with narrow (1 cm) chilled margins and contain centimetre-sized xenoliths of the intermediate metavolcanic wallrock. Although the contacts are irregular all dikes follow the same 070° trend which is subparallel to the main foliation in this part of the map area. The tonalite is characterized by equigranular quartz and plagioclase ($An_{0\text{-}8}$) with interstitial chlorite, carbonate and white mica comprising approximately 50% of the rock. A weak tectonic fabric was observed in thin section and much of the primary mineralogy has been altered. This dike swarm is not related to any known intrusion and the genesis of these dikes is speculative.

PALEOPROTEROZOIC

Mafic Intrusive Rocks (diabase)

A number of north- to northwest-trending diabase dikes correlated by Osmani (1991) with the Paleoproterozoic Matachewan swarm have intruded all rock types in the map area. Diabase dikes were encountered in several drill data and are fine- to medium- grained, equigranular, dark green to black rocks. Plagioclase phenocrysts, so typical of Matachewan dikes in other locales, were not observed in the map area. In thin section a representative sample of a dike was composed of approximately 55% plagioclase ($An_{37\text{-}43}$) and 35% clinopyroxene with minor quartz and magnetite. The diabase dikes are generally easy to trace aeromagnetically where they intrude less magnetic rocks; however, they are difficult to trace where they intrude magnetic ultramafic rocks. The diabase dikes are generally undeformed, weakly altered and intruded along pre-existing structures, most commonly along north- and northwest-trending faults. The Matachewan dike swarm is approximately 2454 Ma (Osmani 1991) and is inferred to be younger than gold mineralization south of the map area (cf. Berger 1992). Dikes are probably more numerous than indicated on Map P.3351 (back pocket) because only those dikes the author was reasonably confident existed are portrayed.

CENOZOIC

Quaternary

PLEISTOCENE AND HOLOCENE

The surficial Quaternary geology of the map area is summarized by Richard (1983). Areally extensive glaciolacustrine deep water varved silts and clays (the Barlow–Ojibway Formation) and Holocene organic deposits of peat and black muck cover much of the map area. Ice-contact stratified drift, glaciofluvial, glaciolacustrine beach and shallow water deposits of the Ice Chest esker underlie western part of Little Township (Richard 1983).

The subsurface Quaternary geology is known from the many overburden drill holes south of the map area (cf. Berger 1994). Two till sheets (the older Matheson Till and the younger Cochrane Formation) and the Barlow – Ojibway Formation occur throughout the map area. The Matheson Till is characterized by grey, sandy to clayey tills and debris flows which are typically moderately to very well compacted with local rock types accounting for 60 to 95% of clasts (Richard 1987). South to southeasterly ice flow directions are indicated (150 to 180°). Matheson till is exposed in cliffs along the west shore of Frederick House River, north of the High Falls dam (Paulen and McClenaghan 1996).

The Barlow – Ojibway Formation conformably overlies the Matheson Till and is characterized by grey, laminated, non-compacted clay and silt (Richard 1987). These sediments were deposited in a glaciolacustrine environment and were locally interbedded with coarse sand and gravel deposits containing clasts from varied distal provenances (Richard 1987). Leahy (1971) provided additional descriptions of the varved clays and silts southeast of the map area on Nighthawk Lake.

The Cochrane Formation gradationally overlies the Barlow – Ojibway Formation and is composed of tan to brownish-grey, non-compact clay and silt deposited as debris flows (Richard 1987). Minor till is present and contains from 20 to 50% Palaeozoic carbonate clasts. The Cochrane Formation represents deposition by the readvance of the Laurentide ice sheet (Richard 1987).

Glaciofluvial and outwash material occur in western Little township as part of the Ice Chest Esker (Richard 1983). Kettles, some of which are water-filled, are on or adjacent to the esker. During or after deposition the esker was partially eroded by wave action from glacial lake Barlow–Ojibway (Hunt 1981). These deposits are locally up to 125 m thick as indicated by drill data.

In adjacent townships to the south a clay to gritty regolith inferred by the author to be Cretaceous has been encountered in several reverse circulation and sonic overburden drill holes (Berger 1994, 1999). The widespread development of a regolith has several implications for the

explorationist. Lateritic gold and nickel deposits may be preserved and overburden drill programs should test the regolith for these minerals. Entrained gold detected in basal till samples may be derived from laterite deposits and therefore may not be representative of unweathered bedrock. Future overburden exploration drill programs should allow for these various parameters when results are interpreted.

Structure and Metamorphism

This chapter will describe the large scale structural features as inferred from geophysical data in the map area. The lack of outcrop prevents a detailed structural synthesis; however, supporting drill and outcrop data are referred to wherever possible. Emphasis will be placed on the style of deformation within and the contact relationships among the various assemblages.

KIDD–MUNRO ASSEMBLAGE

Stratigraphic units within the Kidd–Munro assemblage are east- to east-northeast-trending as indicated by airborne electromagnetic and magnetic features (OGS 1988a, c; Barlow 1988a, b, c). The few outcrop in the western part of Tully Township display a prominent east-northeast-trending penetrative foliation and locally this is overprinted by weakly developed northerly trending fractures and less commonly penetrative foliation planes. Northeasterly closing folds are indicated on the airborne magnetic data (Barlow 1988b) in the western part of Tully Township and reversals in stratigraphic facings in drill data support this interpretation. Drill data at the Nickel Offsets gold deposit, the Intex gold deposit and in Lot 12, Concession V, Tully Township indicate that stratigraphy parallel shear zones occur along some of the lithological contacts. A shear zone identified 500 m northwest of the Nickel Offsets gold deposit extends northeast through the map area and southwest into Wark Township (Berger 1999) indicating that this is a major regional structure. Extensional lineations observed within an east-northeast-trending shear zone at the Intex Gold deposit are moderately northeast-plunging, a direction which is similar to lineations observed in shear zones at Timmins and in the Hoyle Pond gold mine area (Pyke 1982; Berger 1992). This observation implies that the east-northeasterly trending shear zones in the Kidd–Munro assemblage were produced by the same deformational event that affected the Timmins area. These regional scale shear zones are important hosts to gold mineralization and it appears that there is much untested gold potential along these structures in the map area.

There is a change in structural style to northwest-trending structures within a 3 km wide zone of the Kidd–Munro assemblage in the central part of Tully Township. This zone is marked by a northwest-trending fault in the northwestern part of Tully Township, the contact between felsic metavolcanic rocks of the Duff–Coulson–Rand assemblage and mafic metavolcanic rocks of the Kidd–Munro assemblage and the Buskegau River Fault (Map P.3351, back pocket). The Buskegau River Fault is a regional northwest-trending structure which, in part, is the boundary between the Kidd–Munro, Duff–Coulson–Rand and Hoyle assemblages (Berger 1994). The fault is marked by a linear airborne magnetic high in Evelyn Township to the southeast (Berger 1994); however, the fault is less well defined in the map area and is inferred to crosscut the Duff–

Coulson–Rand assemblage in the northern part of Tully Township. Within the 3 km wide zone, easterly and northwesterly trending magnetic units are apparent; however, most electromagnetic conductors are generally northwest-trending. The electromagnetic conductors, commonly coincident with graphitic argillite and sulphide-facies iron formation, are displaced in many places by northeast-trending brittle faults and this has created many numerous, discontinuous units of various rock types. Among the diverse rock types are intermediate metavolcanic rocks similar to those in the Duff–Coulson–Rand assemblage and contacts between these various units are generally sheared and hydrothermally altered. The juxtaposition of the different units is interpreted to be structural and this entire area appears to be part of a large northwest-trending deformation zone marking the contact between the Kidd–Munro and Duff–Coulson–Rand assemblages. The mineral potential of this area is outlined below and similar deformation zones in other parts of the Canadian Shield host major gold deposits.

DUFF–COULSON–RAND ASSEMBLAGE

This assemblage is characterized by rocks of relatively low magnetism compared to the Kidd–Munro and Stoughton–Roquemaure assemblages (OGS 1988a, b; Barlow 1988a, b, c). Northwest-trending magnetic and electromagnetic patterns on geophysical maps are confirmed by bedding trends on outcrop north of High Falls on the Frederick House River. Stratigraphic facings indicate the assemblage youngs to the southwest except in the immediate vicinity of the contact with the Kidd–Munro assemblage where facing reversals occur. In outcrop, the dominant foliation is northwest-trending; however, locally this foliation was observed to overprint and sinistrally rotate an easterly trending foliation. Non-penetrative, northerly trending, fractures and joints crosscut both foliations. Subtle magnetic features enhanced by second vertical derivative maps indicate that north- and northeast-trending faults crosscut the rock units (Barlow 1988b, c). A prominent northwest-trending magnetic anomaly in northern Tully township is coincident with magnetite-jasper iron formation and this is the first place the author has observed this rock type north of Timmins. All these features indicate that the Duff–Coulson–Rand assemblage is fundamentally different than other assemblages in the map area. The limited data base indicates that this assemblage is characterized by shallow water to subaerial calc-alkalic volcanism analogous to modern island arc volcanic settings.

Jackson and Fyon (1991) inferred that dextral shear zones characterized the contact with the Kidd–Munro assemblage in the map area, an inference supported by the mapping. The contact occurs within the 3 km wide deformation zone described above; however, the amount of lateral displacement is unknown as there are no marker units. Further, the Kidd–Munro assemblage is 2710 to 2717 Ma (Heather et al. 1995; Corfu 1993); whereas, the Duff–Coulson–Rand assemblage was dated only once in eastern part of the assemblage (2713 Ma, Corfu 1993). A radiometric age for felsic metavolcanic rocks of the Duff–Coulson–Rand assemblage in the map area would provide better constraint for interpretation of the assemblage model in this part of the Abitibi greenstone belt.

The contact between the Duff–Coulson–Rand and Stoughton–Roquemaure assemblages

is poorly constrained and was observed in only two drill holes in the map area. In each location intermediate metavolcanic flows of the Duff–Coulson–Rand assemblage were intercalated with felsic flows, pyroclastic rocks and quartz-feldspar porphyry correlated with the Stoughton–Roquemaure assemblage. There is no obvious structural discontinuity at the contact although, in one drill hole, hydrothermal alteration and minor shearing was observed. Stratigraphic facings are inconsistent between the drill holes which demonstrates the need for more study at the assemblage scale.

STOUGHTON–ROQUEMAURE ASSEMBLAGE

The Stoughton–Roquemaure assemblage underlies 5% of the map area and only a few drill data have tested the northeastern part of Little Township. Airborne magnetic and electromagnetic data indicate rock units are generally northwest-trending; however, many electromagnetic conductors display limited strike length and it is possible some units trend easterly (OGS 1988b; Barlow 1988a, b, c). The Stoughton–Roquemaure assemblage appears to be in conformable contact with the Duff–Coulson–Rand assemblage (see discussion above); however, there are several reversals of stratigraphic facings which indicate the folding of the rock units about northwest-trending axes. As most of the assemblage occurs outside of the map area, the author is uncertain as to the extent of the folds or if stratigraphy parallel shear zones are present.

HOYLE ASSEMBLAGE

The Hoyle assemblage underlies the southwestern part of Tully Township where it occurs south and north of ultramafic metavolcanic rocks correlated with the Kidd–Munro assemblage. The area south of the ultramafic rocks is not exposed and readers are referred to Berger (1992) for more detailed descriptions of the assemblage in Gowan Township. Clastic metasedimentary rocks that lie north of the ultramafic rocks occur as an 800 m wide unit that is finer-grained than Hoyle assemblage rocks farther south and west (Berger 1992, 1999). Facing reversals in drill data indicate folding about northeast-trending axes in the map area; however, this same unit youngs consistently to the north in Wark Township (Berger 1999). This metasedimentary unit is in shear contact with the Kidd–Munro assemblage and the southern contact forms the structural hanging wall of the Nickel Offsets deposit in the map area. Farther southwest, this same contact displays both sheared and stratigraphic relationships with mafic metavolcanic rocks of the Kidd–Munro assemblage (Berger 1999). The northern contact was not observed by the author to the southwest; however, the metasedimentary unit extends into Kidd Township where it forms the structural footwall to the Kidd Creek base metal deposit. Bleeker et al. (1993) indicated that the metasedimentary unit was 2699 Ma, significantly younger than the 2717 to 2710 Ma Kidd – Munro assemblage. Heather et al. (1995) reported that 2717 Ma and 2683 Ma zircons were also present in the same samples and they concluded that the Hoyle assemblage was a product of turbidite deposition in response to emergence of large land masses following the onset of thrusting and crustal thickening. Although these land masses may have been the major provenance for the assemblage there are areas in Murphy and Wark townships where the older metavolcanic assemblages provided most of the detritus in the form of basal conglomerates with

a high proportion of local clasts and felsic metavolcanic tuff and flows of unknown age (Berger 1999). The older and younger radiometric ages reported by Heather et al. (1995) indicate to the author that the sedimentary basin in which the Hoyle assemblage accumulated was long lived and relatively stable. Although the contacts may be sheared in several places, there is no need to invoke large scale thrusting or strike-slip displacement to juxtapose the metasedimentary rocks with the metavolcanic assemblages in this part of the Abitibi greenstone belt.

A number of late north-, northwest- and northeast-trending faults have cut all assemblages in the map area. The northeast-trending faults are most apparent in the central part of Tully Township where they cut the contact zone of the Kidd–Munro and Duff–Coulson–Rand assemblages and in the northeastern part of Little Township where they cut felsic metavolcanic rocks of the Stoughton–Roquemaure assemblage. In these areas, the faults display various offsets and appear to be brittle, "scissor-type" faults which apparently accommodated movement across the assemblage contact zones. Some of these faults are regional and display sinistral shear movement along strike. The northeast-trending faults at the Nickel Offsets gold deposit and the Intex gold deposit are representative.

The Buskegau River Fault is the most prominent northwest-trending fault and extends southeast and northwest of the map area. This fault forms, in part, the boundary between the Kidd–Munro and Duff–Coulson–Rand assemblages and similar regional scale northwest-trending faults in the Abitibi greenstone belt include the Montreal River and Burrows–Benedict faults in the Timmins area. The Burrows–Benedict Fault displays from 350 to 900 m sinistral offset in the Timmins area (Ferguson et al. 1968) and Berger (1999) indicated at least 80 m of east-side down vertical movement occurred on the fault in Murphy township. Local scale northwest-trending faults occur within the Kidd–Munro assemblage in the map area and a similar sense of movement is inferred for them. These faults are most apparent where they crosscut stratigraphy as in the southwest part of Tully Township. Northwest-trending, stratigraphy parallel faults in the central part of Tully Township are not apparent on geophysical data and therefore not represented on Map P.3351 (back pocket). However, sheared contacts between rock types were observed in drill core and the author believes several faults occur in this part of the map area. In this locale the faults represent possible thrust planes and structural juxtapositioning of rock units is inferred by the author. Matachewan swarm diabase dikes rarely occupy northwest-trending faults in the map area.

North-trending faults are common throughout the map area and many are regional in extent. The north-trending fault that crosscuts the Nickel Offsets gold deposit extends through the map area and can be traced south to Whitney Township east of Timmins (Pyke et al. 1973). The north-trending faults are typically brittle and are accompanied by extensive calcite healed fault gouge and pervasive hematization. The hematization has affected carbonate porphyroblasts which post date at least one period of deformation (Photo 4, Berger 1994). This alteration could be related to Cretaceous weathering described above or to post-Archean movement and alteration on the north-trending faults. East-side down movement is most typical of these faults elsewhere in the region (Berger 1992) and, depending upon the dip of stratigraphic units, apparent dextral or sinistral movement is apparent. Matachewan swarm diabase dikes commonly intruded along

this fault set and several dikes occur in the map area.

Throughout the map area greenschist grade metamorphism is prevalent. Primary clinopyroxene, spinifex and cumulate textures are commonly well preserved in the ultramafic metavolcanic rocks. Where these rocks were subjected to shearing and/or hydrothermal alteration talc, carbonate, chlorite and less commonly sericite and quartz development replaced the primary mineralogy. Primary mineralogy in the mafic metavolcanic rocks is most commonly replaced by chlorite and epidote. Secondary amphibole, indicative of upper greenschist metamorphism is nowhere observed. Primary flows textures are common in hand sample; however, they are not easily discerned in thin section. Calc-alkalic mafic and intermediate metavolcanic rocks in central Little Township display zoned primary clinopyroxene phenocrysts in a very fine-grained epidote- and chlorite-bearing groundmass. There is little evidence of intensive metamorphism in this area. Felsic metavolcanic rocks commonly contain primary quartz and plagioclase phenocrysts in quartz-plagioclase-white mica groundmass. In many thin sections, delicate perlitic cracked fragments and spherules are well preserved. Flow laminations and pyroclastic textures were observed in several areas.

Clastic metasedimentary rocks display low grade metamorphic minerals throughout the map area. Pelitic rocks such as mudstone, siltstone and argillite most commonly contain white mica, chlorite and epidote. These rocks are distinguished by the virtual absence of biotite and this indicates that only the lowest metamorphic facies of the greenschist grade was attained (cf. Winkler 1979).

Alteration

Hydrothermal alteration has affected rocks in several parts of the map area and is distinct from regional metamorphism. Alteration associated with gold mineralization is characterized by ubiquitous pervasive iron carbonate that has affected all rock types. Within the iron carbonate halo, local areas of pervasive and vein sericite alteration occur in close association with quartz veining and gold mineralization. In the central part of Tully Township arsenopyrite and less commonly base metal mineralization accompanies the gold. At the Intex, Frankfield and Nickel Offsets gold deposits where ultramafic rocks are nearby, green mica, vein and pervasive chloritization are common; vein carbonate is more abundant than pervasive alteration, vein biotite and tourmaline are minor. Pyrite is the most common sulphide and base metal mineralization is minor. In northeastern Little Township intense pervasive sericite alteration is situated along the contact between the felsic metavolcanic and graphitic metasedimentary rocks and is in close spatial association with gold mineralization. This alteration system is poorly documented as the area has not been well explored; however, sericite alteration was observed in drill data by the author southeast of gold occurrence in lots 1 and 2, Concession V, Little Township (*see* Economic Geology).

Graphitic carbon is common to all gold occurrences in the map area; a feature which also is characteristic of gold mineralization in Hoyle Township (cf. Berger 1992). The role of carbon

in the deposition and localization of gold mineralization is discussed by Wilson and Rucklidge (1987, 1986) and it appears to have acted as a reductant at the Owl Creek mine. This feature probably explains the success exploration companies have had in testing airborne electromagnetic conductors in the search for gold mineralization.

Stratiform hydrothermal alteration typical of base metal mineralization (cf. Lydon 1988) was not immediately apparent in the map area. Chlorite is widespread in mafic and felsic metavolcanic rocks in the central part of Tully Township; however, its presence may be due to regional metamorphism or, in some of the felsic metavolcanic rocks, due to mechanical mixing with metasedimentary and mafic metavolcanic rocks (i.e., graphite breccia, see above). Previously published geochemical analyses for some of the felsic metavolcanic rocks in this area indicate they are albitized with up to 6.5% Na_2O for silica ranging between 65 and 70%. Albitized felsic metavolcanic rocks are common in parts of the base metal-producing Normetal district in Quebec (D. Brisbin, Falconbridge Inc., personal communication, 1995).

Economic Geology

Three gold deposits (Nickel Offsets, Intex and Frankfield) occur in the western and southwestern parts of Tully Township. Several gold occurrences are reported from the central part of Tully Township and base metal mineralization is reported from the central part of Tully Township and the northeastern part of Little Township. Most of the mineralization is associated with the Kidd–Munro assemblage, although one gold and one base metal occurrence are associated with the Stoughton–Roquemaure assemblage. No significant mineralization is known, as yet, in the Duff–Coulson–Rand assemblage. Table 6 summarizes the exploration history in the map area and presents the most significant results. This chapter will emphasize the major mineralized environments and present recommendations for future exploration. Readers are referred the assessment files, Resident Geologist's Office, Timmins for details of specific properties or areas (Table 6).

GOLD

Intex Gold Deposit

Texmont Mines Limited (Texmont) originally staked 36 mining claims in Prosser and Tully townships in 1968 to explore for base metals (Canadian Mines Handbook 1968-69). Diamond drill testing ground electromagnetic conductors in the south 1/2 of lots 11 and 12, Concession III, Tully Township by Intex Mining Company (Intex) Limited resulted in the discovery of gold mineralization referred to as the "Texmont Zone" with dimensions of 152 by 3.05 m (500 by 10 feet) at a grade of 7.5 grams gold per ton (0.022 ounce gold per ton) (Pearson 1989). In 1974, Frankfield Explorations Limited, under option agreement with Intex, diamond drill tested ground 1200 m east of the Texmont Zone and discovered a second mineralized area (183 by 4.3 m) referred to as the "Frankfield Zone". Subsequent work between 1981 and 1988 resulted in definition of 114 000 tons of 7.5 g/t gold to a depth of 75 m over a width of 3.05 m in the

Texmont Zone and definition of 191 000 tons of 7.9 g/t gold to a depth of 75 m over a width of 4.3 m in the Frankfield Zone (Pearson 1989). A 12 km seasonal road was constructed east from Highway 655 to provide access to the deposits in this time interval. In 1991, Cyprus Gold (Canada) Limited optioned the property and undertook to test, by diamond drilling, the down-plunge extension of mineralization under the Frankfield Zone. Although this program was largely successful, the continuity and grades of the additional mineralization was insufficient to expand the tonnage. No work has been carried out since 1991.

Johnson (1991) indicated that there are two styles of gold mineralization present in the deposits. Structurally controlled, quartz-pyrite-arsenopyrite stringer and vein zones within mafic metavolcanic and metasedimentary rocks is typical of the Texmont Zone and occurs in the hanging wall of the Frankfield Zone. Gold tenor and the extent of quartz veining are most closely linked. Gold is associated with disseminated to semi-massive pyrite-arsenopyrite mineralization in silicified graphitic mudstone and mafic tuff immediately above ultramafic rocks at the Frankfield Zone and is considered to be more significant than the vein type mineralization (Johnson 1991; Pearson 1989). Gold tenor is mostly associated with sulphide content and silicification. Silicification, carbonatization, sericitization and hematization are associated with both ore zones (Pearson 1989).

TEXMONT ZONE

The author examined outcrop near the Texmont Zone, much of the core left at the drill camp by Cyprus Gold (Canada) Limited, assessment drill core stored at the Timmins Drill Core Library and diamond drill logs filed for assessment work credits. Outcrop immediately north of the Texmont Zone consists of massive and pillowed mafic flows which strike 075°, young to the south and dip steeply to the north. These rocks are gradational to the west with outcrops of massive phaneritic mafic flows which are weakly to moderately magnetic and are coincident with an airborne magnetic high (OGS 1988a). All of these outcrops display a weak, easterly trending first foliation and outcrops west of the Texmont Zone display a crosscutting, north-trending, weakly developed, non-penetrative fracture foliation which are locally epidote filled.

Stripping at the Texmont Zone in 1981 revealed quartz stringers in sheared mafic metavolcanic rocks. This area was flooded in 1995; however, the author examined outcrop at the north edge of the stripped area. Here, the intensity of deformation is pronounced at 86° in a north dipping (75°) shear zone. Widely spaced quartz stringers within the shear zone are oriented parallel to the foliation and at 310°. A weakly developed extensional lineation plunges moderately to the northeast. Pervasive carbonate and hematite alteration is moderately developed in the shear zone and rapidly decreases outside the sheared rock to the north. There is less than 1% disseminated pyrite accompanying the alteration and there are numerous chlorite stringers visible at the east end of the stripped area. In places the protolith appears to be a mafic fragmental rock, possibly hyaloclastite. Drill core from a Cyprus Gold (Canada) Limited hole 350 m west of the Texmont Zone encountered moderately carbonate and white mica altered hyaloclastite and flow breccia which may represent the same unit observed at the north edge of the stripped area. Diamond drill core of the Texmont Zone filed by Texmont Mines Limited for

assessment work credits (Timmins Drill Core Library) shows such intense carbonate and sericite alteration of mafic metavolcanic rocks that they are pale white which is possibly the reason early workers indicated the Texmont Zone was hosted in "rhyolite" (Pearson 1989). Although graphite and arsenopyrite were not observed by the author in outcrop they are reported in several diamond drill logs and they do occur in the Cyprus Gold (Canada) Limited drill hole 350 m to the west. A thin section of the altered hyaloclastite from this hole shows pervasive carbonate, white and green mica alteration overprinted by fine "dustings" of carbon and disseminated arsenopyrite. Unaltered and weakly deformed quartz and albite occur as discontinuous stringers and pods throughout the rock. These observations indicate that the alteration system is complex and extends well beyond the ore zone.

The author agrees with Johnson (1991) that the Texmont Zone is structurally controlled. The easterly trending shear zone appears to be the primary locus for gold mineralization and it would appear that the shear zone extends well beyond the mineralization. The Frankfield Zone is inferred to be the fault-offset eastern extension of the Texmont Zone; however, there appears to be only limited testing of the western part of the shear zone. Airborne electromagnetic anomalies in the north 1/2 of Lot 1, Concession II, Prosser Township (OGS 1988c) may represent the fault-offset western extension of the Texmont Zone and may warrant exploration.

FRANKFIELD ZONE

The Frankfield Zone was discovered as a result of testing airborne electromagnetic conductors which were believed to represent the fault-offset extension of the Texmont Zone (Pearson 1989). There is no outcrop in the immediate area of the deposit and the author examined diamond drill core and logs from the Frankfield Zone. Two styles of mineralization are evident (described above) and previous workers believed the stratiform mineralization to be more economically significant than the vein style of mineralization. In drill core the stratiform mineralization is characterized by a graphitic mudstone intercalated with mafic tuff, hyaloclastite and mafic flow breccia which is similar to the host rock at the Texmont Zone and in the Cyprus Gold (Canada) Limited diamond drill hole farther west. The mudstone and mafic fragmental rocks are strongly contorted and display a pronounced foliation which the author infers is parallel to the shear zone at the Texmont Zone. Disseminated, semi-massive and vein pyrite, arsenopyrite and lesser amounts of pyrrhotite comprise up to 50% of the unit over a few centimetres but in most places averages less than 5%. Quartz veining, pervasive silicification and carbonatization accompany the sulphide minerals but this alteration is not as intense as in the Texmont Zone. Pervasive and vein chlorite, tourmaline and minor biotite alteration was observed in several places by the author in drill core from the Frankfield Zone. In thin section, brown tourmaline and iron-rich chlorite veins are parallel to and crosscut the primary foliation whereas, carbonate and biotite stringers generally crosscut and are rotated by the primary foliation. The chlorite and tourmaline alteration is less pronounced at the Texmont Zone; however, biotite was observed in thin sections of outcrops of phaneritic mafic flows on the Tully – Prosser township boundary approximately 1500 m to the west. Hematite alteration at the Frankfield Zone is generally confined to fractures and is less pervasive than at the Texmont Zone.

In summary, the Texmont and Frankfield zones are complex deposits with a number of features typical of Archean lode gold mineralization (cf. Colvine et al. 1988). Limited field work by the author indicates that both zones are hosted in an easterly trending shear zone and that mafic fragmental and graphitic metasedimentary rocks are the host rock types. The intense carbonatization has obliterated most of the primary features which has hampered identification of the host rock at the Texmont Zone. North-trending faults with inferred east-side down vertical displacement have disrupted the ore zones (Map P.3351, back pocket) and it is possible that the differences in mineralization and alteration styles between the two deposits may be explained if the Frankfield Zone is assumed to be at a higher crustal level of deposition of the same hydrothermal system. If this assumption is true, exploration in Prosser Township may reveal the location of widespread, deep-seated gold mineralization. Pearson (1989) inferred that the gold mineralization appeared to be localized by the north-south faulting; however, the author believes this fault set is largely post mineralization but possibly introduced hematite which caused redistribution of the gold.

Nickel Offsets Deposit

Nickel Offsets Limited acquired 30 mining claims in Tully Township in 1964 subsequent to the discovery of the Kidd Creek base metal deposit. Sixteen claims were allowed to lapse and the remaining 14 were optioned to McIntyre Porcupine Mines Limited in 1968 who tested electromagnetic conductors for base metal mineralization. Gold-bearing quartz carbonate veins were encountered in graphitic "tuff" at the northern contact between clastic metasedimentary and ultramafic metavolcanic rocks. McIntyre drilled 4474 m (14 675 feet) in 25 holes and Nickel Offsets Limited drilled an additional 6415 m (21 043 feet) in 33 drill holes (Moxham 1982). Noranda Exploration Company Limited optioned the property in 1987 and, in turn, optioned part ownership of their interest to Golden Princess Mining Corporation. Golden Princess diamond drilled a further 9004 m (29 535 feet) in 44 holes on the property to the end of 1988. Diamond drill indicated ore reserves calculated at the end of 1981 consisted of 650 000 tons at 0.23 ounce gold per ton over a strike length of 427 m (1400 feet) with widths between 1.5 and 5.4 m (5 to 18 feet) (Kuryliw 1981). More recent calculations are not publically available. In 1985, Nickel Offsets Limited was amalgamated into Canhorn Mining Corporation which recently changed their name to Canhorn Chemical Corporation (Canadian Mines Handbook 1995-96) and this company is the current owner of the Nickel Offsets deposit.

The Nickel Offsets deposit consists of a set of quartz filled fractures, mineralized with coarse visible gold (Kuryliw 1981). The fractures are inferred to exist as at least six en echelon vein sets each trending east-northeast and dipping 50 to 60° to the north with a 20° easterly plunge (Kuryliw 1981). The vein sets occur within an easterly trending structure and are hosted within graphitic "mafic tuff" at the contact between footwall ultramafic flows and sills and hanging wall clastic metasedimentary rocks. Much of the visible gold occurs only in east-northeast-trending quartz veins and pyrite, sphalerite, chalcopyrite, galena and rarely arsenopyrite are accessory (Kuryliw 1981). Carbonate and chlorite alteration accompany the quartz veining (Moxham 1982). North-trending brittle faults have sinistrally offset the gold deposit and

hematization is preferentially sited in these faults. One fault is interpreted to extend north to offset the Frankfield gold deposit and this same fault has been interpreted by Pearson (1989) to extend south to the Pamour gold deposit in the Timmins area.

As there is no outcrop in the vicinity of the Nickel Offsets deposit, the author examined drill core during the 1995 field season from several holes drilled by Golden Princess Mining Corporation and stored on site. Drill core and drill logs from adjacent properties filed for assessment work credits and stored at the Timmins Drill Core Library were also examined as were geophysical maps. The hanging wall metasedimentary rocks are composed of fine-grained wacke, siltstone, graphitic and non-graphitic mudstone. These rock types are generally thinly bedded to laminated and commonly display grain gradation and load casts; rarely pebble conglomerate was observed. Schist is common within shear zones and adjacent to the contact with the footwall ultramafic rocks. North and south stratigraphic younging indicates folding of the metasedimentary rocks about east-northeast-trending axes is common. The metasedimentary rocks are contiguous to the southwest with similar rocks which were interpreted by Berger (1999) to have been deposited by turbidity currents in a quiet water environment.

The foot wall of the Nickel Offsets deposit is a 2800 by 600 m east-northeast-trending unit of ultramafic komatiitic flows and sills which have been intruded by tonalitic feldspar and quartz porphyry dikes and stocks. The ultramafic flows are largely altered to talc-chlorite-carbonate schist; however, spinifex and rubbly flow textures are locally well preserved. Massive, cumulate textured ultramafic rocks are common throughout the foot wall sequence and may, in part, be intrusive. A pronounced high magnetic response characterizes the ultramafic rocks in the foot wall (OGS 1988a). Approximately 600 to 800 m southwest of the gold deposit, feldspar and quartz porphyry has intruded the ultramafic rocks. The porphyry is characterized by white and black varieties which are spatially intermixed. In thin section the white variety of porphyry is composed predominantly of porphyritic albite and minor quartz in an albite groundmass with accessory amphibole and carbonate and minor amounts of chlorite and finely disseminated opaque minerals. The black porphyry is composed of albite and quartz with accessory biotite and carbonate. Opaque minerals assumed by the author to be graphite and sulphides occur as discrete grains and coatings around the silicate minerals and as finely disseminated "dustings". The opaque minerals and biotite account for the colour variation in the porphyry. The porphyry corresponds with a low intensity magnetic anomaly on geophysical maps. Felsic porphyritic dikes are reported in diamond drill logs farther to the east in the foot wall and also occur within the Nickel Offset ore zone (see below).

The ore zone of the Nickel Offsets deposit is described in all diamond drill logs as "tuff" or "mafic tuff". In drill core examined by the author the "tuff" is composed of sheared metasedimentary, mafic and ultramafic metavolcanic rocks and in one drill hole the sheared equivalent of the feldspar-quartz porphyritic rocks described above was observed. These rock types have been carbonatized, chloritized and locally sericitized and pervasively silicified. Hematite alteration is generally fracture controlled but locally pervasive hematization is strongly developed. In many places the ore zone is strongly graphitic and contains disseminated pyrite. In thin section the "tuff" is characterized by a strongly developed anastomosing foliation along

which most of the chlorite, quartz and graphite have been introduced. Magnesium- and iron- rich chlorite also occurs in sigmoidal veins with sulphides indicating that at least some of the chlorite is secondary and not a product of regional greenschist grade metamorphism. Carbonate is common throughout the "tuff" but is generally not as intensely developed as in some of the gold deposits in the Timmins camp.

The author has inferred that the "tuff" unit is coincident with an easterly trending fault based on the intensity of the foliation and description of the vein sets. Quartz veins containing albite, chlorite and less commonly sulphides cut across the foliation and gold is spatially associated with an east-northeast-trending vein set (Kuryliw, 1981). The host "tuff" unit becomes narrow and discontinuous southwest of the ore deposit; however, quartz veining with erratic gold mineralization persists into northeastern Wark Township (Berger 1999). East of the gold deposit the "tuff" thickens and becomes recognizable as massive and pillowed mafic flows in the north 1/2 of Lot 10; however, gold mineralization decreases to the east. Similar "tuff" units were encountered in diamond drill holes 350 m north and 700 m northeast of the Nickel Offsets gold deposit where they are coincident with strongly deformed rocks and interpreted by the author to be in a shear zone. Gold mineralization has not yet been reported in this area.

Kuryliw (1981) indicated that sufficient ore reserves exist on the Nickel Offsets property to warrant underground exploration. Although additional reserves were not reported by Golden Princess Mining Corporation, assay results filed for assessment work agrees with Kuryliw's conclusion. The main obstacle to underground work is the depth of overburden (30 m avg.) which precludes open pit development at this time. However, it appears that in order to advance the economic feasibility of the project, the Nickel Offsets gold deposit requires underground development and exploration. Graham (1987) concluded that the southern contact between the ultramafic and metasedimentary rocks was a favourable exploration target that had not been tested. In the author's opinion, this area would be a greatly enhanced target if there was strong evidence of a shear zone or fault coincident with the contact. To date, the available geophysical data is inconclusive in this regard. Graham (1987) also concluded that the felsic porphyritic rocks southwest of the gold deposit were a favourable exploration target because they were a host rock susceptible to brittle failure which would trap mineralizing fluids. The porphyritic rocks southwest of the gold deposit do not display extensive deformation but do appear to have undergone weak potassic alteration (see above). Tonalitic rocks similar to the groundmass in the porphyry occur within the ore zone and this indicates that the felsic rocks are spatially associated with gold mineralization in at least one place. Attempts to locate areas where other felsic rocks may occur within the ultramafic metavolcanic foot wall may prove successful in locating additional gold mineralization.

The Nickel Offsets deposit contains many features typical of Archean lode gold deposits (Colvine et al. 1988). Based on the descriptions in the drill logs and the limited observations made by the author, the ore zone appears to be related to extensional veining in a shear zone system (cf. Colvine et al. 1988) in which case exploration along strike and down plunge of the shear zone is recommended. Diamond drilling by Golden Princess Mining Corporation indicates that a northeast-trending shear zone occurs north of the ore body and the author has interpreted

this structure to extend through southeastern Prosser Township into adjoining Wark Township based on geophysical data. Exploration along this structure, especially if it deflects into an easterly trend, is recommended.

Hollinger Mines Limited Gold Occurrence

Hollinger Mines Limited staked 23 mining claims over parts of lots 4, 5, 6, and 7, Concession IV in Tully Township in 1969. Seven diamond drill holes (Table 6) were completed to test ground electromagnetic conductors, apparently for base metal mineralization, between 1970 and 1973. Graphitic mudstone and disseminated graphite in sheared metavolcanic rocks accounted for the anomalous conductivity and base metal assay values up to 5440 ppm Cu and 3710 ppm Zn were returned over 1.5 m. In one drill hole, gold mineralization (0.4 ounce gold per ton over 0.9 m) was encountered in quartz veined and carbonate altered "dacite". Anomalous gold (up to 0.07 ounce gold per ton) and silver (up to 20 ppm) assays were returned from other drill holes in the same area. Esso Minerals Canada Limited (Hollinger's successor company) carried out diamond drilling (Table 6) in the immediate vicinity of the gold mineralization in 1987. This drilling confirmed the presence of a wide carbonate-silica-sulphide alteration zone within which a gold-bearing quartz vein occurred. The best assay returned from this drill program was 26.8 g/ton over 2.04 m (report filed for assessment work credits 1991). In 1989 Homestake Canada Limited (Esso's successor company) acquired the claim group and 10 diamond drill holes were completed in 1991 (Table 6). This drilling tested west to northwest-trending electromagnetic conductors and several gold assays between 1000 to 3000 ppb (maximum 7000 ppb over 0.5 m) were returned from carbonatized, sericitized and graphitic metavolcanic and metasedimentary rocks. The mineralization was considered to be too low grade and sporadic to warrant further exploration and the ground has not been explored since 1991.

Diamond drill core and logs stored at the Timmins drill core library from the Hollinger and Homestake exploration programs were examined by the author. The majority of these holes were drilled from north to south to test formational electromagnetic conductors with which the gold mineralization was inferred to be associated. In general, the structural hanging wall in most of the drill holes is mafic metavolcanic rocks which are composed of massive, pillowed, variolitic and graphitic brecciated varieties. Narrow (less than 20 m thick) massive and polysutured ultramafic metavolcanic flows are interlayered with the mafic rocks and locally graphitic mudstone occurs. These rocks are variously deformed but deformation intensity generally increases toward the structural footwall to the south. The footwall is composed predominantly of graphitic mudstone and wacke; however, in many places brecciated mafic flows containing substantial graphite and chlorite stringers are interlayered with the metasedimentary rocks. Some of the northwestern-most Hollinger Mines Limited drill holes passed through a narrow graphitic mudstone unit and re-entered mafic metavolcanic flows. The contact between the hanging wall and foot wall units is obscured by intense deformation and hydrothermal alteration. Chlorite veining, green mica and quartz-carbonate veining are inconsistently developed within a broader alteration halo composed of pervasive carbonatization, sericitization and patchy silicification. Sulphide minerals consisting mostly of pyrite with lesser

amounts of arsenopyrite, chalcopyrite and sphalerite occur erratically in amounts from 1 to 30% over narrow intervals. Gold mineralization is erratically concentrated within the alteration and tends to be preferentially associated with arsenopyrite, quartz veining and the most intensely deformed rocks.

To date, all diamond drilling has concentrated on testing electromagnetic conductors, apparently in the belief that gold mineralization was controlled by conductive materials. Bending (1991), however, indicated that there was a northwesterly trending thrust fault between the hanging wall and the footwall and that the gold mineralization was associated with graphitic material in this structure. Bending (1991) also indicated that a number of northeast-trending faults crosscut the thrust fault and the stratigraphy. Similarly, the author has inferred the presence of several northeast-trending faults throughout the central part of Tully Township (Map P.3351, back pocket). The author also observed that many of the better gold assays are closely associated with the intersection of the northeast-trending faults and the inferred thrust fault. Future exploration at the Hollinger gold occurrence should concentrate on testing the northeast-trending fault system. Berger (1992) noted that high grade gold mineralization is localized in east-northeast- to northeast-trending structures in Hoyle Township, site of the Hoyle Pond mine.

Newmont Exploration Canada Gold Occurrences

In 1980, Abitibi Price Incorporated discovered gold mineralization in Lucas Township approximately 6 km northwest of Tully Township. Newmont Exploration of Canada Limited acquired 73 mining claims in Duff and Tully townships to explore for gold in the southeast extension of the same stratigraphy as in Lucas Township (Markov 1982). Newmont geologists' believed that the gold mineralization was syngenetic and localized in chert-pyrite exhalite horizons known to occur in the central part of Tully Township (G. Herran, personal communication, 1982). Ground geophysical surveys were carried out to locate the conductive exhalite units and several diamond drill holes were completed between 1981 and 1984 (Table 6). Gold mineralization with potentially economic grades (Table 6) was encountered in several diamond drill holes; however, lateral and vertical continuity of the mineralization could not be established and Newmont abandoned interest in the area. The gold mineralization occurred within massive pyritic and graphitic chert horizons and in hydrothermally altered and tectonically deformed zones. Markov (1982) indicated that there were several subparallel northwest-trending chert horizons in the central part of Tully Township and that fold repetition and original volcanic stratigraphy accounted for their presence. Observations made by the author after examination of core and logs from several of the Newmont Exploration Canada drill holes are summarized below.

SOUTH 1/2 LOT 8, CONCESSION V, TULLY TOWNSHIP

Four diamond drill holes were sunk to test a northwest-trending electromagnetic conductor. Each hole intersected graphitic and massive pyritic chert bands interbedded with clastic metasedimentary rocks at the contact between massive and tectonically brecciated felsic to

intermediate metavolcanic flows and massive, leucoxene-bearing mafic flows. The mafic metavolcanic rocks are variously schistose, carbonate and sericite altered. Minor quartz veining, pervasive silicification and green mica alteration occurs erratically. Disseminated pyrite content varies between 1 to 5% and there are numerous graphite filled veins and shear zones in the rocks.

The felsic metavolcanic rocks are composed of massive aphanitic grey to white flows, minor spherulitic textured flows, lapilli tuff and tuff. These rock types are characteristically fractured with graphite and chlorite in-fillings creating the graphite breccia unit described above (General Geology). The author interpreted the breccia as tectonic with remobilized carbon and chlorite in the veins.

White and black chert mixed with graphitic metasedimentary and metavolcanic schist are characteristic of the conductive zone and may be as thick as 30 m (true thickness). Within these rock types massive, semi-massive, disseminated and concretionary pyrite occurs in up to 3 m widths. This entire unit is commonly schistose or occurs as contorted and disrupted beds and may exhibit minor pervasive silicification, quartz, graphite and/or chlorite veining. Azurite was observed in drill core from one hole and fracture controlled hematite was observed in a second hole. The drill logs indicate and the author agrees that this unit is likely exhalitive in origin. The author believes that this unit is the locus of a northwest-trending shear zone and may possibly represent a thrust fault. Discrete zones of shearing or brecciation within the mafic and felsic metavolcanic rocks may represent crosscutting faults which the author inferred to occur in the area (Map P.3351, back pocket). Elevated gold assays display close correlation with the massive and semi-massive pyrite within the exhalite unit. Gold values from 100 to 1000 ppb are common and narrow intervals range between 1000 to 2000 ppb. The highest gold assay reported (2545 ppb over 1.5 m) occurred within a 3 m thick massive pyrite unit accompanied by graphite and elevated arsenic (up to 175 ppm). The highest gold values occur in the vicinity of a northeast-trending fault which is inferred to crosscut the exhalite unit. Future exploration in this area should concentrate on testing this northeast-trending structure.

NORTH 1/2 LOT 11, CONCESSION V, TULLY TOWNSHIP

Newmont Exploration Canada sank 1 diamond drill hole in 1983 and 3 more in 1984 to test ground electromagnetic conductors spatially associated with anomalous gold mineralization (Table 6). The drill hole in 1983 encountered quartz-ankerite veining in leucoxene-bearing mafic flows which returned an assay of 0.15 ounce gold per ton over 1.2 m. Weak pervasive carbonate and hematite alteration accompanied the veining. The 1984 diamond drill program attempted to trace the lateral extent of the mineralization without success and no further work was carried out on the claim group. The electromagnetic conductors in this area were correlated with graphitic and pyritic metasedimentary rocks which occur as interflow units between mafic and ultramafic metavolcanic rocks and as beds within a clastic metasedimentary unit interpreted to be up to 350 m thick. Carbonate and sericite alteration was weakly to moderately developed in the metavolcanic rocks and hematite was observed by the author to be closely associated with diabase dikes which were intruded into the metasedimentary rocks. Dome Exploration (Canada) Limited carried out diamond drilling in the same general area in 1973 and all of the

electromagnetic conductors encountered by their program were correlated with graphitic mudstone that carried nil gold and silver and elevated based metals up to 0.35% Zn and 0.14% Cu (Table 6).

Diamond drill core examined by the author indicates that gold mineralization discovered by Newmont Exploration of Canada Limited is structurally controlled and occurs in quartz-carbonate veined mafic metavolcanic rocks. The exhalitive graphitic and pyritic units in this area contain minor gold and future exploration should concentrate on searching for and testing hydrothermally altered structures.

NORTH 1/2 LOTS 8, 9, CONCESSION IV, TULLY TOWNSHIP

Newmont Exploration Canada Limited drilled 9 holes in this area to test electromagnetic conductors associated with gold mineralization. The first hole drilled in north 1/2 of Lot 8, Concession IV encountered silicified mafic metavolcanic flows that returned assays of 0.25 ounce gold per ton over 0.9 m and 0.14 ounce gold per ton over 0.6 m in association with semi-massive pyrite and arsenopyrite (assays up to 3500 ppm As). Duplicate assays of this material by Newmont Exploration Canada returned 0.26 and 1.41 ounce gold per ton. Several other narrow zones of silicified and carbonate altered mafic flows returned from 100 to 4600 ppb gold. In this same hole a 1.1 m interval of massive pyrite and graphitic metasedimentary rocks returned 27600 ppm Zn, 7600 ppm Cu and only 26 ppb Au. Diamond drill holes along strike, down dip and testing parallel electromagnetic conductors failed to encounter mineralization as impressive as that in the first hole; nevertheless, gold assays up to 0.17 ounce gold per ton over 1.1 m were returned from quartz-carbonate altered, pyritic and arsenopyritic mafic metavolcanic flows. The highest gold assay associated with massive pyrite in graphitic mudstone and chert returned 1716 ppb Au over 0.6 m. Cincinnati–Porcupine Mines Limited explored the north 1/2 of Lot 9 in 1969 and reported a gold assay of 0.1 ounce per ton over 0.3 m in graphitic felsic metavolcanic rocks.

Drill core from several of the diamond drill holes stored at the Timmins drill core library were examined by the author. Narrow, northwest-trending, units of ultramafic and mafic metavolcanic flows interlayered with graphitic and pyritic metasedimentary rocks and black pyritic chert underlie much of the north 1/2 of lots 8 and 9. Felsic metavolcanic flows, lapilli tuff, tuff and tectonically derived graphitic breccia were observed by the author in the north 1/2 of Lot 8 and this unit is interpreted to extend northwest into Concession V and VI (Map P.3351, back pocket). Quartz-feldspar porphyritic dikes intruded the metasedimentary units in a couple of diamond drill holes. In most of the drill holes, the contacts are characterized by moderate to intense shearing and this deformation extends into the adjacent units especially the ultramafic and metasedimentary rocks. Felsic metavolcanic and porphyritic rocks are commonly brecciated with graphite and chlorite veins near the contacts. Deformation in the mafic metavolcanic rocks is variable. In some drill holes, relatively undeformed sections of mafic flows separate narrow zones of intense shearing. In other drill holes the mafic rocks display wide carbonatized, sericitized and silicified alteration zones in which weak to moderate quartz-carbonate veining is developed. Local "windows" of relatively unaltered of mafic rocks occur within these zones. Although these alteration zones appear undeformed they commonly display a moderate to strong

preferred crystal orientation or foliation in thin section.

Significant gold mineralization is strongly associated with arsenopyrite and silicification in the mafic metavolcanic rocks as demonstrated by the assays reported on the Newmont Exploration Canada drill logs. The mineralization occurs within carbonatized and sericitized alteration zones and lesser amounts of green mica, pyrite, hematite and tourmaline may be present. Elevated gold does occur within the cherty, graphitic and pyritic metasedimentary units; however, potentially economic mineralization was not encountered. The tendency for Newmont Exploration Canada Limited to drill the northwest-trending electromagnetic conductors indicates that they believed the gold mineralization was controlled by syngenetic sulphide and graphite-bearing exhalite horizons. The association of gold with hydrothermally altered and deformed mafic metavolcanic rocks indicates to the author that the mineralization is more likely structure controlled, similar to the Texmont, Frankfield and Nickel Offsets deposits (described above). As the contacts between the major rock types are commonly sheared, there appear to be northwest-trending shear zones in the area. The author also notes that the Newmont drill holes with the highest grade gold mineralization occur near interpreted northeast-trending faults and it is this fault set that warrants future exploration.

Norcen Energy Resources Limited Gold Occurrence

Norcen Energy Resources Limited explored ground electromagnetic conductors in the south 1/2 of Lot 4, Concession VI of Little Township in 1980 with 2 diamond drill holes. In one drill hole a 1.8 m interval of "graphitic chert" returned 0.13 gold which the author infers to be ounce gold per ton. Norcen carried out no further work on this claim group.

Although the drill core from these holes are stored at the Timmins drill core library there is insufficient material to resample the gold-bearing interval. However, the drill core indicates that the gold mineralization is hosted in silicified and carbonatized, graphitic and concretionary pyritic mudstone and schist which occurs as a 3 m thick continuous unit between felsic pyroclastic and mafic to intermediate metavolcanic flow rocks. Intense pervasive sericitization and weak silicification extends for 6 m from the graphitic unit into the felsic rocks. Weak sericitization and carbonatization extends for 14 m from the graphitic unit into the mafic metavolcanic flows. The graphitic metasedimentary unit appears to have acted as a conduit along which hydrothermal fluids passed. The alteration persists for at least 700 m to the southeast as indicated in diamond drill holes completed by Aurizon Mines Limited and Samim Canada Limited (Table 6). However, gold mineralization was not encountered by either of these companies. There has been no exploration northwest of the Norcen diamond drill hole and it appears likely that the alteration extends in this direction. It is possible that gold mineralization may be encountered to the northwest especially in the vicinity where northeast-trending faults crosscut the graphitic horizons.

BASE METALS

The discovery of the Kidd Creek base metal deposit, in 1964, sparked extensive base metal exploration throughout the entire Timmins area. At this time several companies explored small claim groups throughout the map area (Table 6). Exploration has concentrated on diamond drill testing electromagnetic conductors especially those with coincident high intensity magnetic anomalies. Many of the conductors tested in the map area proved to be graphitic mudstone with anomalous concentrations of pyrite and pyrrhotite. Assay results were not reported for many of diamond drill holes but those results that were filed indicate low base metal content for much of the graphitic material. Of notable exception are drill holes sunk by Dome Exploration (Canada) Limited and Newmont Exploration Canada Limited in northwestern Tully Township. Exploration by Hollinger Mines Limited also encountered anomalous base metal concentrations in Tully Township is association with gold mineralization. Base metal exploration in Little Township was concentrated in the northeast and southwest corners where several electromagnetic conductors were drill tested.

Dome Exploration (Canada) Limited Occurrences

Dome Exploration (Canada) Limited explored parts of lots 10 to 12, concessions IV to VI in Tully Township in 1973. Seven diamond drill holes (Table 6) tested northwest-trending electromagnetic conductors which proved to be graphitic and pyritic mudstone interbedded with wacke, mafic and felsic metavolcanic flows. In one drill hole 0.065% Cu and 0.35% Zn is reported over 4.6 m in a graphitic unit at the contact between wacke and mafic metavolcanic flows. In the same drill hole 0.25% Zn is reported over 9 m in a second graphitic unit. In a second drill hole approximately 1200 m southeast of the first hole, 0.14% Cu and 0.25% Zn over 0.9 is reported in graphitic mudstone. Although these assays are not economic, they are anomalous in copper and zinc compared to the rest of map area and ,in particular, to graphitic mudstone units in the general vicinity (Berger 1992, 1999). Chalcopyrite and sphalerite are not mentioned in the drill logs which is interpreted to indicate the base metals occur in the pyrite and carbon of the graphitic units. Stratiform alteration commonly associated with base metal deposits is not described in the drill logs and this indicates that the source of the base metals is not in the immediate vicinity of the drill holes. Future exploration should be directed along the strike of the graphitic units to the northwest.

Newmont Exploration Canada Limited Occurrence

Exploration in the central part of Tully Township by Newmont Exploration of Canada Limited concentrated on testing northwest-trending electromagnetic conductors (see above). In one diamond drill hole in the north 1/2 of Lot 8, Concession IV, a massive pyrite and black graphitic chert unit interlayered between ultramafic metavolcanic rocks returned 27600 ppm Zn and 7600 ppm Cu over 1.1 m. A narrow silicified alteration zone stratigraphically overlay the mineralization. Significant gold mineralization associated with pyrite and arsenopyrite was encountered 120 m farther down the hole in foliated and altered mafic metavolcanic flows (see

above). Diamond drill holes 100 m on either side of this drill hole failed to encounter additional mineralization and no further work was carried out.

Drill core stored at the Timmins drill core library indicates that the base metal mineralization is hosted in a narrow sulphide and graphite-rich metasedimentary unit interpreted by Newmont geologists and the author as an exhalite (cf. Lydon 1988). The lack of lateral continuity of the mineralization as demonstrated by diamond drilling indicates that the mineralization is local and probably deposited distal to the source of the volcanic emanations. Nevertheless, the grade of the mineralization in this drill hole, especially in consideration of the elevated zinc values described above, indicates that exhalite units in the central part of Tully Township are prospective horizons for base metal mineralization. Airborne electromagnetic conductors in the northern part of Lot 12, Concession VI appear to be on strike with the mineralization described above and warrant investigation. The general stratigraphy continues northwest into Lucas and Duff townships and these areas may warrant exploration.

Hollinger Mines Limited Occurrence

During the course of their exploration program in lots 6 and 7, Concession IV, Tully Township Hollinger Mines Limited encountered elevated base metal concentrations associated with gold mineralization. Copper and zinc assays up to 5440 ppm and 3710 ppm, respectively, were encountered in schistose and highly altered metavolcanic rocks. The drill core stored at the Timmins drill core library is incomplete but the mineralization appears to be mainly in veins and along foliation planes within the alteration zones indicating that it is secondary in origin. It is possible that the mineralization was remobilized from graphitic and metavolcanic units in the immediate vicinity of the diamond drilling.

The base metal values reported by Hollinger Mines Limited are not impressive when considered in isolation of the surrounding geology. However, exploration along strike to the northwest by Dome Exploration and Newmont Exploration (see above) indicates that there is a consistent pattern of anomalous to subeconomic base metal mineralization in the stratigraphy in this part of Tully Township. The exploration, to date, indicates that the anomalous base metal mineralization is confined to northwest-trending exhalitive units located west of the Buskegau River Fault and east of a northwest-trending fault in the western part of Tully Township. There are untested electromagnetic anomalies in lots 8 and 9, Concession V and lots 11 and 12, Concession VI which may prove to contain base metal mineralization. The favourable stratigraphy continues into Lucas and Duff townships and these areas should be examined for untested conductors.

Base metal mineralization is reported in the northeast corner of Little Township. Amoco Canada Petroleum Company Limited diamond drill tested a northwest-trending electromagnetic conductor in Lot 2, Concession V and encountered 0.14% Cu, 0.15% Zn and 0.05 ounce silver per ton over 0.3 m of pyritic quartz vein material at the contact between mafic and felsic metavolcanic flows. The general geology and alteration in this part of Little Township is

favourable for base metal mineralization; however, the Amoco results appear to represent an isolated concentration of mineralization which was remobilized into quartz veins. Several companies (Table 6) have tested the on-strike extension of this stratigraphic package in Little Township and did not encounter similar concentrations of base metals. The felsic metavolcanic rocks in Little Township are characterized by pyroclastic tuff, lapilli tuff and autoclastic flows which were distally deposited. Perhaps base metal accumulation is more abundant outside the map area.

There has been little concentrated effort directed toward nickel and copper exploration in the map area. Assays reported from numerous diamond drill logs indicate that nickel concentrations up to 2500 ppm are associated with ultramafic rocks devoid of sulphide mineralization. In such cases the author infers that the nickel is associated with silicate minerals. In Lot 1, Concession VI of Little Township, the International Nickel Company of Canada Limited (Table 6) encountered 0.23% Cu and 0.3% Ni over 0.55 m in one of three diamond drill holes sunk to test ultramafic rocks. Fracture controlled pyrite and pyrrhotite accompanied the mineralization and the author infers the base metals are associated with the sulphides. The author has interpreted the ultramafic rocks to be intrusive as they are reported to be massive; flow features such as spinifex and polysuturing were not reported in the drill logs. The ultramafic rocks are characterized by high magnetic patterns (OGS 1988b) and are part of a much larger complex which extends north and east of the map area. It is possible that komatiitic flows occur within this complex in which case komatiitic-hosted nickel deposits may be present.

Recommendations to Prospectors

GOLD

Nickel Offsets deposit

Over 100 diamond drill holes have defined and tested the area surrounding the deposit. The next logical phase of work for the deposit would involve underground exploration and development (Kuryliw 1981). There are some areas in the vicinity of the deposit which could be tested by surface exploration. Airborne electromagnetic conductors (OGS 1988a) inferred to lie along the southern contact between the ultramafic and metasedimentary rocks warrant examination because gold is preferentially associated with graphitic material in the ore zone. Gold potential would be enhanced if a shear zone coincident with the conductivity were present.

The ultramafic metavolcanic rocks are inferred to be dextrally offset by a north-trending fault in Lot 9, Concession I of Tully Township (Map P.3351, back pocket). A number of electromagnetic conductors (apparently untested) occur near the fault and the contact of the ultramafic and metasedimentary rocks. This area is recommended for exploration.

The feldspar porphyry intrusion southwest of the ore deposit has been intersected in only

one diamond drill hole. Felsic porphyry displays a strong spatial association with gold mineralization in the Timmins camp (Colvine et al. 1988) and there are felsic rocks similar to the porphyry within the Nickel Offsets ore zone. It is recommended that the feldspar porphyry be explored to define its limits and test its relationship with gold mineralization.

There is an east-northeast-trending shear zone at the contact of the ultramafic and metasedimentary rocks that is associated with the gold mineralization. This shear zone extends southwest into Prosser and Wark townships (Berger 1999). Limited diamond drilling in these two townships have encountered alteration which should be further explored in the author's opinion. Parallel shear zones hosting carbonate and sericite alteration were discovered to the north of the Nickel Offsets deposit by diamond drilling. It is recommended that these structures be explored along strike to the southwest and northeast. It is possible that favourable conditions for gold mineralization occur in Lot 9, Concession II, Tully Township and in Lot 1, Concession I, Prosser Township.

Intex Gold Deposit

TEXMONT ZONE

Exploration in the immediate vicinity of the gold deposit appears to have adequately defined the mineralized zone. However, favourable carbonate, green mica and sericite alteration continue west along with the host structure into Prosser Township where there has been minimal exploration. It is recommended that the western part of the structure in Tully and Prosser townships be explored. Magnetic data (OGS 1988a, c) shows that there is a sharp northeast-trending gradient that coincides with the Intex deposit and that this gradient extends southwest into lots 1, 2, Concession II, Prosser Township. Electromagnetic conductors coincident with the gradient should be tested for their gold potential.

FRANKFIELD ZONE

As with the Intex deposit, exploration to date appears to have adequately defined the main and western parts of the mineralized zone. Extensional lineations at the Intex deposit plunge moderately to the northeast and the author believes that the Frankfield ore zone may also plunge in this direction. Exploration down plunge and along strike to the northeast is warranted.

Gold mineralization in the central part of Tully Township is spatially associated with the intersection of northeast-trending faults and northwest-trending sulphide-chert-graphite stratigraphic units. Carbonate-sericite-silica alteration is associated with the gold mineralization and arsenopyrite is a common accessory mineral. Previous exploration that concentrated on testing the stratigraphy could not establish the continuity or tenor of the mineralization. Future exploration should concentrate on testing the northeast-trending structures and in mapping the carbonate, sericite and silicified alteration which is a useful vector to the gold mineralization. Local scale northeast-trending faults were geophysically inferred from apparent offsets in the

northwest-trending electromagnetic conductors (OGS 1988a) and further work is warranted along these structures (Map P.3351, back pocket). Faults in lots 8 and 9, concessions IV and V would be the most prospective in the author's opinion. Some northeast-trending faults in lots 5 to 8, Concession IV and V appear to be regional structures and the most intense carbonate-sericite alteration appears to be associated with them. The gold mineralization in lots 6 and 7, Concession IV should be tested by additional exploration along the northeast-trending faults.

Gold mineralization in northeastern Little Township is associated with intense silicification and sericitization of graphitic metasedimentary rocks interbedded between mafic and felsic metavolcanic rocks of the Stoughton–Roquemaure assemblage. Limited exploration along strike to the southeast encountered similar alteration without gold mineralization. The northwest extension of the stratigraphy has not been tested and exploration is recommended. Northeast-trending faults are geophysically inferred to crosscut stratigraphy in this part of the map area and their relationship to gold mineralization is unknown. However, it is likely that the faults have a similar role in localizing alteration and mineralization as in the central part of Tully Township.

BASE METALS

Copper-zinc mineralization in central Tully Township is associated with stratigraphic units composed of graphitic chert and sulphide-facies iron formation of the Kidd–Munro assemblage. Although mineralization widths and tenor are variable along strike, in an individual unit there are several parallel units in the map area, not all of which have been adequately explored. Airborne electromagnetic conductors in lots 11 and 12 Concession VI, have not been thoroughly explored (OGS 1988a). Airborne conductors in the south 1/2 of lots 8 and 9, Concession IV are located near the contacts with felsic metavolcanic rocks and have not been adequately tested (OGS 1988a). Airborne conductors in the south 1/2 of Lot 10, Concession IV (OGS 1988a) are located at the contact between felsic and ultramafic metavolcanic rocks and diamond drilling farther west encountered massive pyrite and pyrrhotite with minor chalcopyrite. This area is recommended for further exploration.

The Kidd Creek ore body was discovered by diamond drill testing electromagnetic conductors flown along east-west flight lines. Stratigraphy is north-trending in the vicinity of the mine (Heather et al. 1995). Throughout the Kidd–Munro assemblage there are a number of places where airborne magnetic patterns indicate east- and west-closing folds or local north-trending stratigraphy. These areas should be considered for their base metal potential. Government airborne geophysical surveys were flown along north-south flight lines and electromagnetic conductors aligned parallel or oblique to the flight lines may not have been detected or their strengths underestimated. Consideration should be given to flying airborne surveys along east-west flight lines in structurally complicated areas.

There are few obvious base metal targets within the Duff–Coulson–Rand assemblage. Previous drill testing of airborne electromagnetic conductors (OGS 1988a, b) along the southwest

contact of the assemblage encountered graphitic argillite and pyritic sulphide-facies iron formation barren of base metals. Although there remain many untested conductors along this contact, it appears that most are caused by graphitic material. There are 2 parallel sets of untested airborne conductors in lots 6 and 7, Concession V, Tully Township which the author interprets to result from structural juxtaposition. This area warrants examination for its base metal and gold potential.

There is a 900 m wide felsic metavolcanic unit with associated electromagnetic conductors at its contact underlying northeastern Tully and northwestern Little townships. Previous exploration either failed to locate the conductors with surface geophysical equipment or did not adequately test located conductors. It is recommended that the conductors in Lot 12, Concession V, Little Township and in lots 2, 3, and 4, Concession VI, Tully Township be examined. Further exploration along strike to the northwest in Duff Township is also recommended.

There are a number of isolated, untested airborne electromagnetic conductors east of the Frederick House River in Little Township (OGS 1988b). The inferred geology, intermediate calc-alkalic pyroclastic and epiclastic rocks, is not a favourable host for volcanogenic massive sulphide deposits; nevertheless, Lydon (1988) indicated that some deposits did occur in these rocks. Conductors in Lot 4, Concession IV should be tested.

Electromagnetic conductors associated with felsic metavolcanic rocks of the Stoughton–Roquemaure assemblage have proven to be caused by graphitic argillite where diamond drill tested. However, there remain several untested anomalies and those in Lot 2, Concession V and Lot 4, Concession VI appear to have the most potential for base metal mineralization.

Copper-nickel mineralization was discovered in Lot 1, Concession VI, Little Township by drill testing airborne electromagnetic conductors associated with ultramafic rocks of the Stoughton–Roquemaure assemblage. As most of the ultramafic rocks in this assemblage lie north and east of the map area, it is recommended that these areas be explored.

Ultramafic metavolcanic rocks within the Kidd–Munro assemblage represent channelled and over bank levee flows (cf. Hill et al. 1990). Graphitic and pyritic metasedimentary rocks occur as interflow units in many places and in some drill data, ultramafic flows were observed to have mechanically incorporated some of this material (graphite breccia). The search for komatiitic nickel-copper deposits should concentrate on locating the thick channelized portions of the flows where sulphide deposition is most likely to have occurred. The thicker ultramafic units occur in lots 6, 7, Concession I, lots 3, 4, 8 to 12, Concession II, Tully Township.

Appendix 1: Drill Hole Compilation for Little and Tully Townships

Drill Hole #	Azimuth	Inclination	Assessment File #	Easting	Northing
Little Township					
NORCEN TP-80-9	40	-60	42A15SW0150 25	500950	5403665
NORCEN TP-80-10	220	-60	42A15SW0150 25	501541	5403908
AURIZON AF-2	220	-55	T-3327	501685	5403837
AURIZON AF-1	220	-50	TI-3423	501985	5403710
SAMIN TP-82-5A	220	-60	42A15SW0147 28	502296	5403668
SAMIN TP-82-6	220	-50	42A15SW0147 28	502537	5403744
SAMIN TP-82-4	40	-55	42A15SW0148 27	501495	5403123
INCO 6231	60	-90	42A15SW0159 10	504130	5404276
INCO 6232	225	-45	42A15SW0159 10	504089	5404274
INCO 6233	25	-45	42A15SW0159 10	504048	5404275
SAMIN TP-82-7	220	-50	42A15SW0147 28	502713	5402699
AURIZON AF-5	220	-50	TI-3425	503447	5402706
MASSVAL #2	180	-62	42A14SE0404 12	494902	5402555
MASSVAL #3	176	-60	42A14SE0404 12	495563	5402831
MASSVAL #4	356	-60	42A14SE0404 12	495578	5402667
NORCEN TP-80-6	180	-65	42A11NE0109 24	495455	5398957
NORCEN TP-80-5	360	-60	42A11NE0109 24	495783	5399001
NORCEN TP-80-7	270	-60	42A11NE0109 24	496823	5399258
NORANDA T1-78-1	215	-50	42A11NE0113 22	496367	5397942
HOLLINGER LT-1	245	-55	42A11NE0133 11	495299	5397314
NORANDA T1-78-5	180	-45	42A11NE0114 23	497741	5397330
NORANDA T1-78-4	180	-45	42A11NE0114 23	498471	5397456
VANGULF 24-1	180	-60	42A11NE0132 16	499564	5398280
LACANA T80-7	360	-55	42A11NE0111 26	495048	5396626
AMOCO 5-1	202	?	42A15NE0015 21	494877	5395360
AMAX TX-98-73	220	-50	42A15SW0157 18	500801	5404600
VANGULF 66-1	230	-60	42A15SW0158 15	503870	5403928
VANGULF 66-2	230	-60	42A15SW0158 15	503987	5403724
AURIZON AF-6	220	-45	42A15SW0144 2.1	503818	5404337
AURIZON AF-7	220	-55	42A15SW0144 2.1	503681	5404170
AURIZON AF-8	220	-55	42A15SW0144 2.1	503567	5404042
DOME 110-16	227	-55	42A15SW0154 19	498704	5404539
MAGOMA #4	65	-45	T-531	495110	5397340
AMAX TX-80-71	225	-50	TI-0965	502275	5403567
AMOCO TO-6A-1	190	-55	TI-1215		
LACANA LBT-31	-	-90		494622	5397457
LACANA LBT-33	-	-90		495613	5397073
Tully Township					
NORANDA TU-69-1	180	-50	TI-1785	487676	5398585
NORANDA TU-69-7	211	-50	TI-1786	487749	5398713
ROSARIO T80-3	225	-55	TI-1530	492114	5395551
ROSARIO T80-1	360	-55	TI-0163	493345	5395276

Appendix 1 (cont'd)

Drill Hole #	Azimuth	Inclination	Assessment File #	Easting	Northing
ROSARIO T80-5	360	-55	TI-1531	491075	5396341
MATTAGAMI 68-3	360	-60	T-1443		
DAERING 65-1	360	-50	TI-2658	488975	5399537
DAERING 65-2	360	-50	TI-2659	489089	5399355
DAERING 65-3	360	-50	TI-2660	488779	5399380
DAERING 65-4	360	-50	TI-2925	488781	5399229
DAERING 65-5	360	-50	TI-2926	489573	5399178
NORANDA T73-8	30	-50	TI-1029	488803	5399838
LACANA T82-16	180	-50	TI-0191	491029	5396423
ABITIBI L82-55	225	-50	TI-1263	486894	5401603
NORCEN TP80-4	180	-60	TI-0037	490136	5401058
NEWMONT MC84-1	45	-70	TI-0357	486386	5402925
NEWMONT MN83-9	220	-50	TI-0092	488725	5400938
NEWMONT B82-2	221	-50	TI-0062	488564	5402251
NEWMONT B81-1	196	-50	TI-0058	488327	5402297
NEWMONT B82-1	190	-50	TI-0061	488215	5402290
LACANA T83-18	45	-55	TI-1426	488652	5396533
LACANA T83-19B	210	-65	TI-1427	489849	5398184
NORCEN TP81-5	180	-50	TI-0048	490863	5401463
NEWMONT MC84-3	45	-50	TI-0359	486314	5403016
NEWMONT MN83-4	225	-50	TI-0087	488380	5401680
TEXMONT 69-TO-1	25	-50	TI-1139	489194	5403479
KEEVIL T65-7	360	-52	TI-3090	485570	5396573
TEXMONT 69-TN-1	180	-50	TI-1137	489192	5403708
TEXMONT 69-TN-2	360	-50	TI-1138	489731	5403344
NORANDA TU-69-3	160	-50	TI-1269	485245	5395942
NORANDA TU69-4A	160	-50	TI-1270	485057	5395931
UTICA #1	180	-50	TI-0866	491071	5401308
LAROMA T-1	0	-90	TI-1147	490857	5399161
NORANDA TU 69-2	180	-50	TI-1148	491028	5396279
NORANDA TU 69-6	180	-50	TI-1149	491277	5396197
KIDD TU-52-1	215	-55	TI-1896	487995	5402763
KIDD TU-52-2	215	-55	TI-1897	487859	5402902
KIDD TU-52-3	215	-55	TI-1973	487700	5403016
KIDD TU-52-4	215	-55	TI-2259	487589	5403147
ABITIBI L82-54	210	-50	TI-0439	487278	5401504
INCO 32906	45	-55	42A14SE0142 28	487697	5401006
ESSO T91-01	210	-55	42A11NE0004 60	491534	5399888
McINTYRE 22-69-3	343	-60	42A11NE0048 23	492174	5395983
MATTAGAMI 68-2	360	-60	42A14SE0143 25	486503	5400228
DOME 43-1	30	-55	42A14NE0140 33	486733	5403632
DOME 43-1A	210	-55	42A14NE0140 33	486887	5403762
DOME 43-2	30	-55	42A14NE0140 33	486024	5403208
DOME 43-3	30	-55	42A14NE0140 33	486087	5402613
DOME 43-4	30	-55	42A14NE0140 33	485935	5402385
DOME 43-6	210	-55	42A14NE0140 33	487266	5402262
DOME 43-7	210	-55	42A14NE0140 33	486992	5401535

Appendix 1 (cont'd)

Drill Hole #	Azimuth	Inclination	Assessment File #	Easting	Northing
HOLLINGER 1-70	180	-50	TI-2235	490613	5400300
HOLLINGER 2-70	180	-55	TI-2236	490082	5400487
HOLLINGER 3-70	180	-53	TI-2237	489691	5400426
HOLLINGER 4-72	180	-55	TI-2238	489529	5400516
HOLLINGER 5-72	60	-55	TI-2335	489530	5400572
HOLLINGER 6-73	180	-55	TI-2256	489401	5400553
HOLLINGER 7-73	180	-55	TI-2257	489046	5400670
NEWMONT MC83-1	45	-50	TI-0081	486342	5401289
NORANDA 73-7	210	-50	TI-1028	488770	5399335
P. C. T69-4	160	-55	TI-1788	486839	5396922
P. C. T69-5	155	-60	TI-1789	487332	5396757
NORCEN TP80-1	360	-60	42A11NE0032 45	487710	5398287
ROSARIO T80-13	180	-55	42A11NE0029 47	491816	5396470
ST JOSEPH 134-1B	25	-50	42A11NE0235 40	492799	5397554
ST JOSEPH 134-2	345	-50	42A11NE0235 40	492160	5397536
KIDD 41-01	180	-50	42A11NE0216 59	485305	5400426
HOLLINGER LT-2	245	-60	42A11NE0041 12	493502	5399913
ROSARIO T82-17	180	-50		491402	5396507
LACANA T82-15A	210	-60		489833	5398105
C.PORCUPINE 69-1	225	-45	T-1469	488029	5401579
C.PORCUPINE 69-2	45	-45	T-1469	488071	5401040
C.PORCUPINE 69-3	225	-45	T-1469	488558	5401369
KEEVIL T69-1	157	-60	TI-3345	485574	5396168
KEEVIL T69-2	153	-60	TI-3346	485731	5396247
KEEVIL T69-3	160	-60	TI-3347	485774	5396380
NEWMONT MN83-1	225	-50	TI-0084	488536	5401156
ROSARIO T80-14	45	-50	TI-0164	491031	5396056
ROSARIO T80-6	360	-55	TI-2629	489095	5395352
NEWMONT B-82-3	222	-50	TI-0063	488726	5402015
NEWMONT MC83-2	45	-50	TI-0082	485750	5402064
NEWMONT MN83-2	225	-55	42A14SE0115 57	489122	5401978
NEWMONT MN83-6	45	-50	TI-0089	488162	5401204
NEWMONT MN83-5	45	-50	TI-0088	487911	5401248
ROSARIO T80-4	360	-55	T-1945	491517	5395492
ROSARIO T80-8	360	-50	T-1945	491405	5396104
ROSARIO T80-11	200	-55	T-1945	490088	5398348
MATT. TK-78-2	180	-50	T-1923	492820	5401483
MATT. TK-78-3	205	-45	T-1923	493802	5399921
AMOCO 77-8-1	45	-60	TI-1219	493927	5397920
AMOCO 77-5A-1	22	-50	TI-1217	492757	5396347
AMOCO 77-5A-2	22	-50	TI-1216	492955	5396459
LAROMA T-68-1	205	-57	T-1419	491415	5395895
UNITED COM #1	180	-55	T-893	491739	5400559
UNITED COM #2	180	-55	T-893	491606	5400683
UNITED COM #3	360	-55	T-893	491740	5400449
QUEST. 76-TT-1	198	-60	42A11NE0037 38	488440	5396205
QUEST. 76-TT-4	180	-60	42A11NE0037 38	488287	5396279

Appendix 1 (cont'd)

Drill Hole #	Azimuth	Inclination	Assessment File #	Easting	Northing
QUEST. 76-TT-3	210	-55	42A11NE0037 38	489609	5395828
W. MINES 80A-1	180	-61	T-1885	486339	5400058
W. MINES 80-A-2	180	-62	T-1885	486101	5400392
W. MINES 80-A-3	180	-61	T-1885	486222	5400487
W. MINES 80-B-2	180	-61	T-1885	485709	5401878
T.G.S. 51-1	153	-50	T-814	485475	5401852
T.G.S. 43-1	210	-50	T-814	488029	5400677
HOMESTAKE T91-2	180	-50	T-3338	489835	5400410
HOMESTAKE T91-3	180	-50	T-3338	489956	5400329
HOMESTAKE T91-4	180	-50	T-3338	490081	5400320
HOMESTAKE T91-5	180	-50	T-3338	490196	5400291
HOMESTAKE T91-8	180	-55	T-3338	490315	5400321
HOMESTAKE T91-9	180	-50	T-3338	489720	5400501
TRUSS #1	-	-90	T-557	485450	5397073
TRUSS #2	-	-90	T-557	485315	5396938
T.G.S T-15-1	210	-50	T-449	491904	5395998
CON. NOVELL 2A	180	-60	T-975	490981	5400864
MCINTYRE 92069-1	315	-45	42A11NE0044 20	486941	5398632
MCINTYRE 92069-2	135	-45	42A11NE0044 20	486703	5398723
MCINTYRE 92069-3	180	-50	42A11NE0044 20	486556	5398797
DESSON 93-CD-2	180	-55	T-3531	492793	5397740
DESSON 92-CD-1	165	-55	T-3531	492045	5397758
NO87-4	170	-60	42A11NE0215	485889	5396414
NO87-11	180	-60	42A11NE0215	486591	5396583
NO87-12	180	-60	42A11NE0215	486447	5396123
NO87-13	180	-55	42A11NE0215	486439	5396253
NO87-14	325	-60	42A11NE0215	485966	5396744
NO87-18	135	-60	42A11NE0215	485116	5395914
NO87-20	180	-60	42A11NE0215	486776	5396536
NO87-21	180	-60	42A11NE0215	487089	5396602
NO87-23	180	-60	42A11NE0215	487360	5396659
NO87-25	318	-60	42A11NE0215	485708	5395818
NO87-33	180	-72	42A11NE0215	486179	5396533
NO87-35	150	-60	42A11NE0215	485667	5396239
CYPRUS T-91-1	180	-66	T-3528	486458	5398622
CYPRUS T-91-2	180	-60	T-3528	486533	5398538
CYPRUS T-91-4	180	-60	T-3528	486298	5398562
CYPRUS T-91-7	180	-61	T-3528	485075	5398485
INTEX 81-14	45	-50		486723	5398298
INTEX 81-15	45	-50		487307	5398185
INTEX 82-3	147	-50		486025	5398632
NO88-26	150	-50	42A11NE0215	486781	5397335
NO88-41	150	-50	42A11NE0215	486373	5397095
COMINCO TO-2	-	-90	42A11NE0014	493017	5397973
COMINCO TO-14	-	-90	42A11NE0014	493056	5398394
COMINCO TO-15	-	-90	42A11NE0014	492633	5398390
COMINCO TO-16	-	-90	42A11NE0014	492251	5398394

Appendix 1 (cont'd)

Drill Hole #	Azimuth	Inclination	Assessment File #	Easting	Northing
COMINCO TO-17	-	-90	42A11NE0014	492201	5399175
COMINCO TO-18	-	-90	42A11NE0014	491804	5399167
COMINCO TO-19	-	-90	42A11NE0014	491450	5399167
COMINCO TO-5	-	-90	42A11NE0014	491450	5398766
COMINCO TO-4	-	-90	42A11NE0014	490639	5399550
COMINCO TO-22	-	-90	42A11NE0014	491817	5399550
COMINCO TO-23	-	-90	42A11NE0014	492624	5399555
COMINCO TO-25	-	-90	42A11NE0014	491813	5400003
COMINCO TO-26	-	-90	42A11NE0014	492250	5400001
LACANA LBT-1	-	-90		487818	5395936
LACANA LBT-2	-	-90		488090	5395940
LACANA LBT-3	-	-90		488364	5395962
LACANA LBT-6	-	-90		489051	5395274
LACANA LBT-7	-	-90		489203	5395930
LACANA LBT-8	-	-90		489340	5395612
LACANA LBT-9	-	-90		489424	5395194
LACANA LBT-11	-	-90		489819	5395645
LACANA LBT-13	-	-90		489802	5397719
LACANA LBT-15	-	-90		490252	5395953
LACANA LBT-16	-	-90		490285	5397565
LACANA LBT-19	-	-90		490769	5396941
LACANA LBT-20	-	-90		490888	5396692
LACANA LBT-21	-	-90		491073	5395973
LACANA LBT-23	-	-90		491313	5395979
LACANA LBT-27	-	-90		491853	5395709
LACANA LBT-29	-	-90		492496	5395628
LACANA LBT-28	-	-90		492129	5396296
LACANA LBT-30	-	-90		493119	5395264

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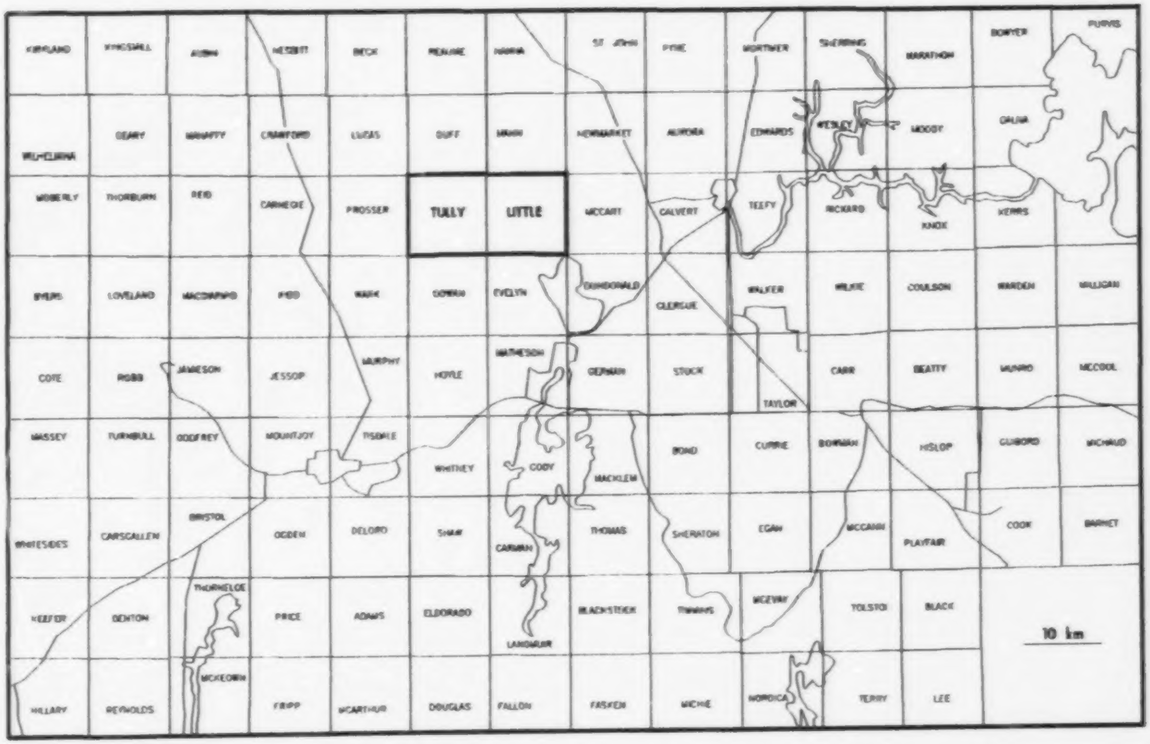

Figure 1. General Location Map for Tully and Little Townships.

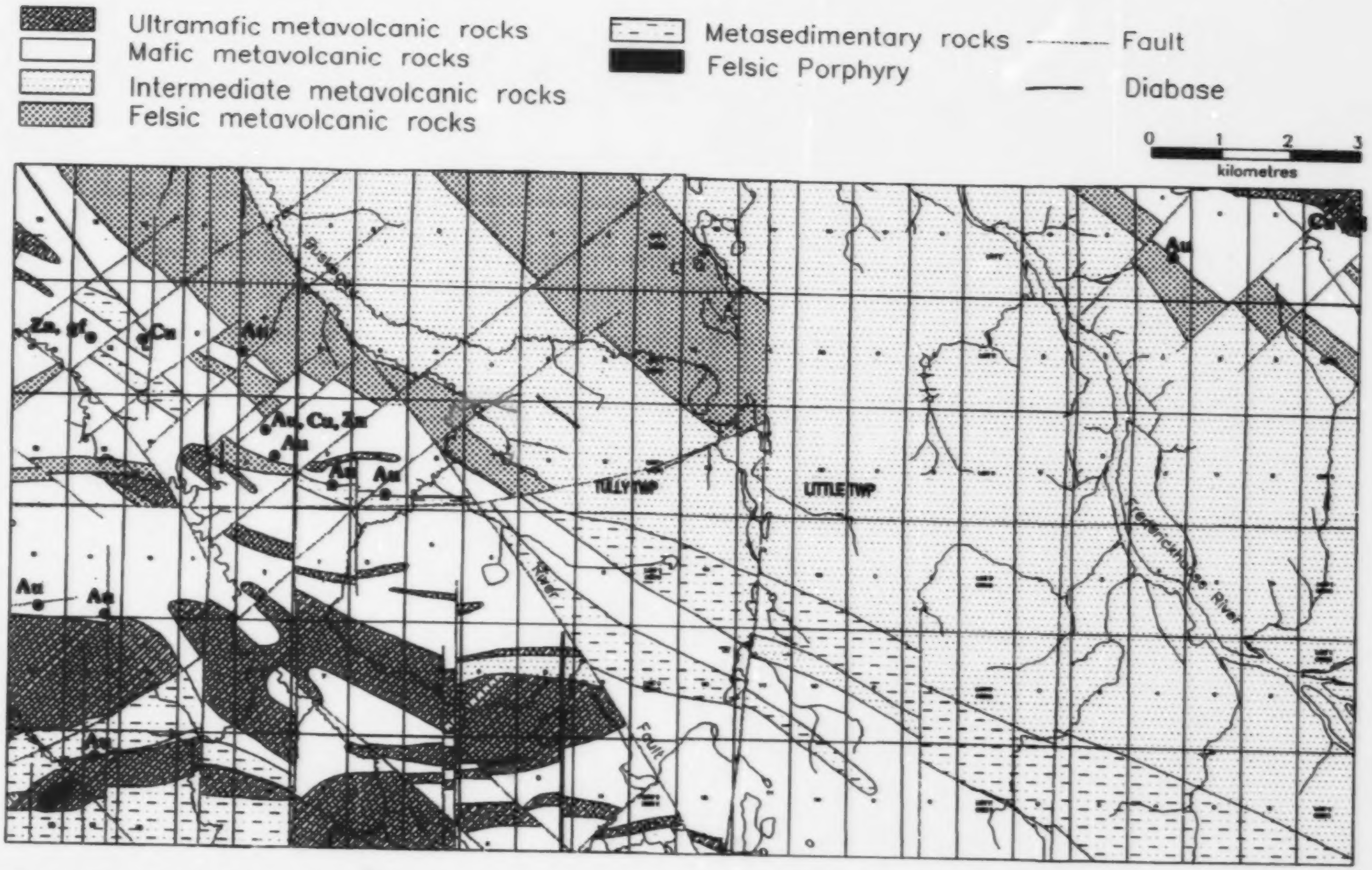

Figure 2. General Geology of Tully and Little Townships.

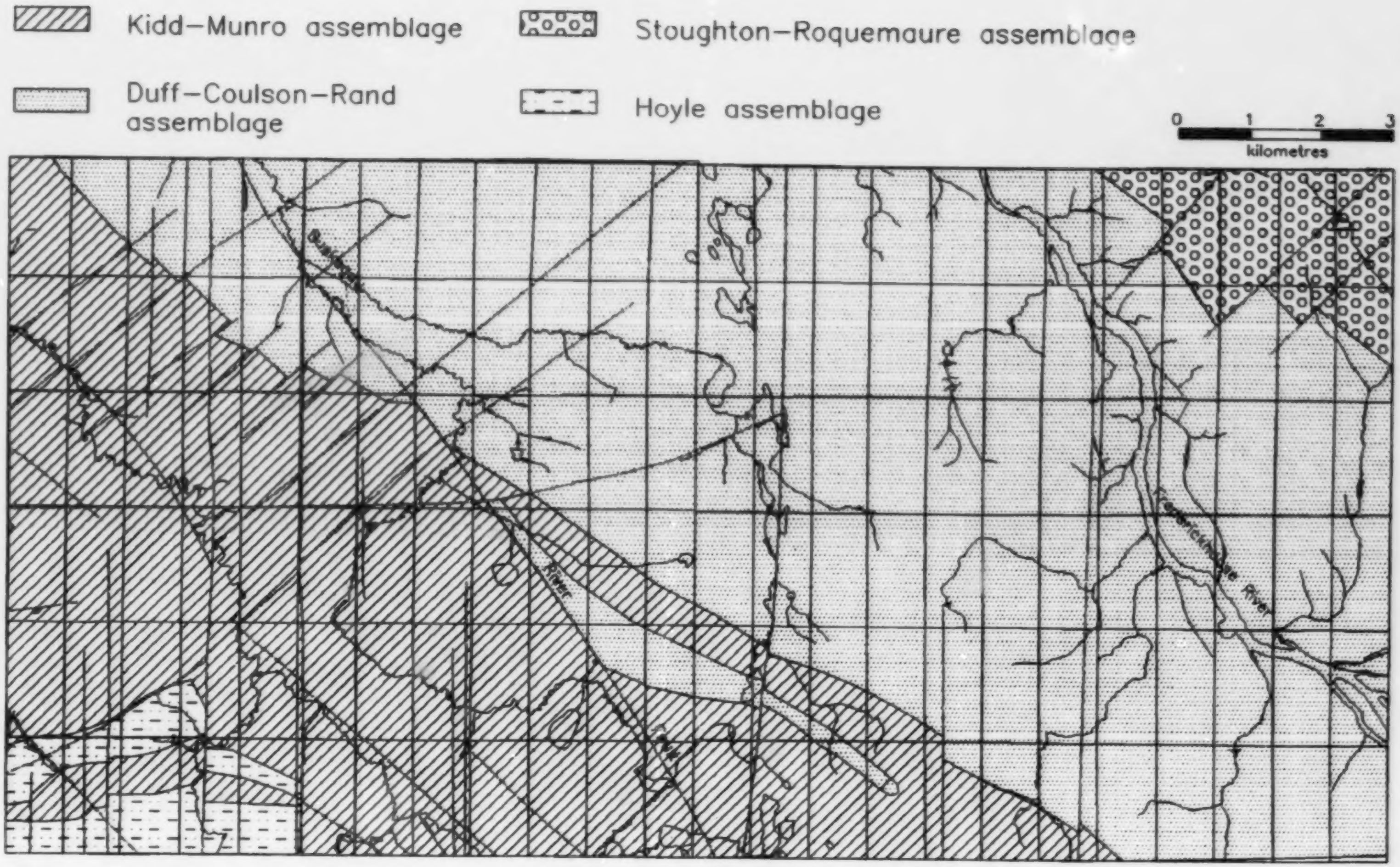

Figure 3. Assemblage Map for Tully and Little Townships.

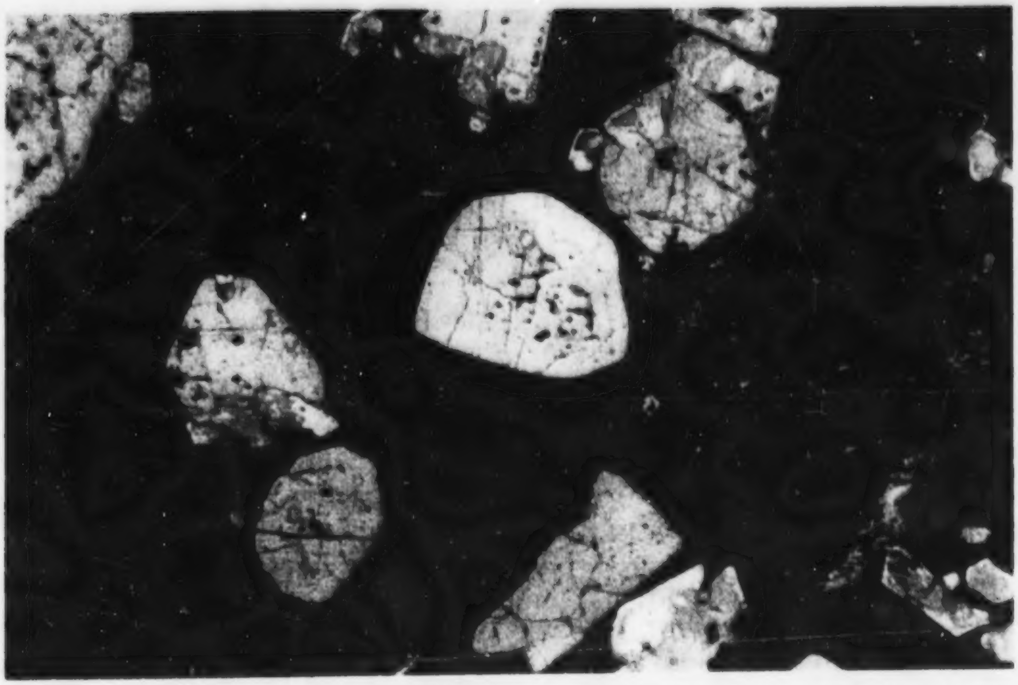

Photo 1. Euhedral primary clinopyroxene and altered plagioclase phenocrysts in intermediate metavolcanic pyroclastic fragment from the Duff–Coulson–Rand assemblage, Lot 7, Concession V, Little Township. Field of view 8 mm, plane polarized light.

Photo 2. Epiclastic tuff breccia at High Falls in Little Township. The reaction rim and shape of the centre clast is indicative of aerodynamic shaping and rapid cooling of airfall tephra. Duff–Coulson–Rand assemblage.

Photo 3. Perlitic cracks in spherule from felsic metavolcanic flow in the Kidd–Munro assemblage. Lot 8, Concession V, Tully Township. Field of view 4mm, plane polarized light.

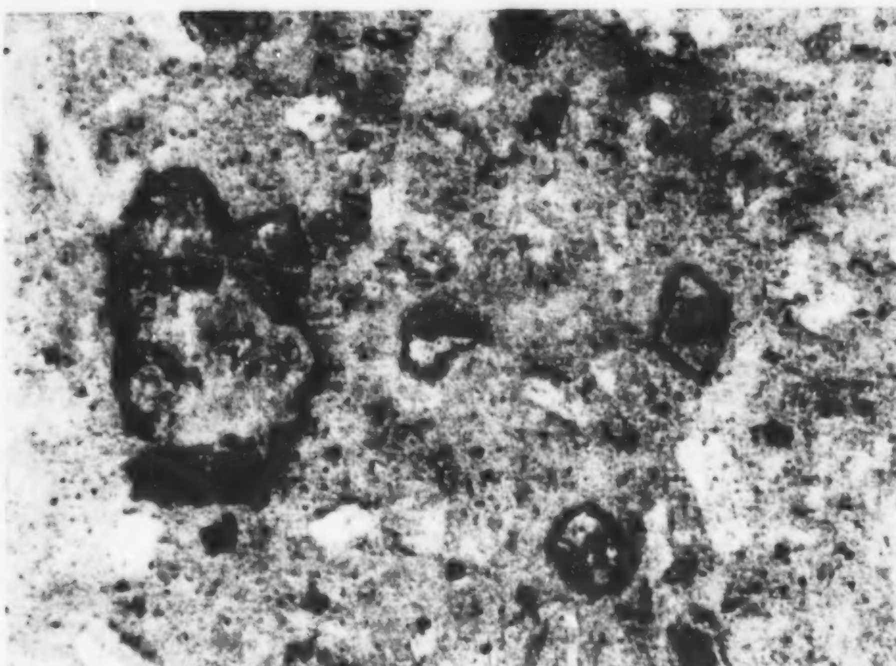

Photo 4. Hematized felsic metavolcanic flow of the Duff–Coulson–Rand assemblage from Lot 11, Concession V, Little Township. Carbonate porphyroblasts rimmed by hematite attest to late alteration of the rock that is attributed to a nearby north trending fault. Field of view 4 mm, plane polarized light.

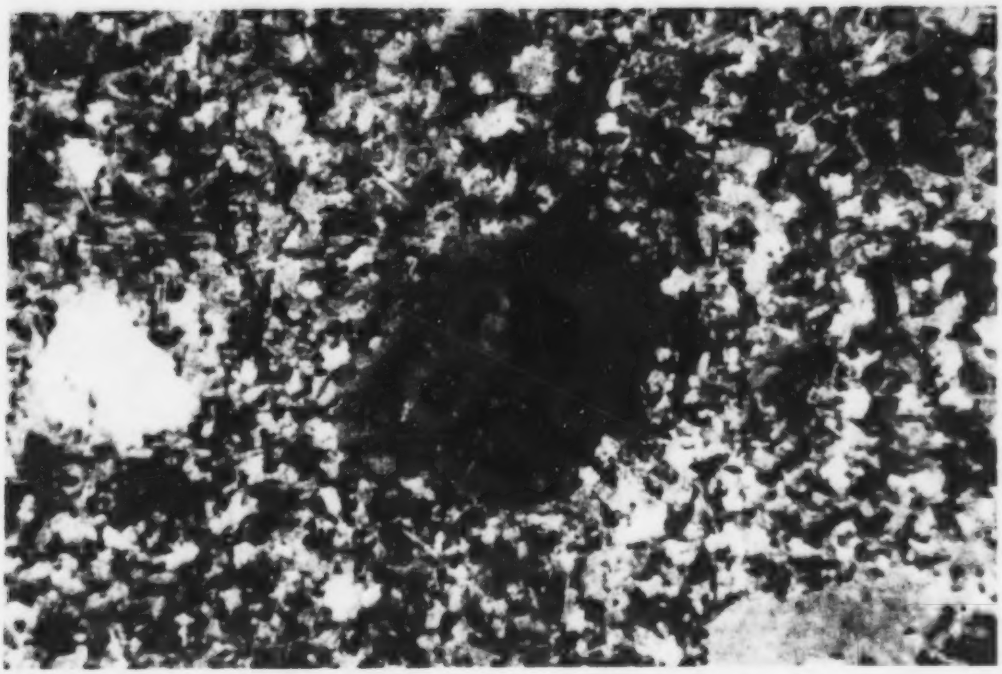

Photo 5. Euhedral albite phenocryst in quartzo-feldspathic groundmass from quartz-feldspar porphyry southwest of the Nickel Offsets gold deposit. Lot 12, Concession I, Tully Township, Kidd-Munro assemblage. Field of view 4 mm, crossed nichols.

Table 1. Lithological Units for Tully and Little townships.

PHANEROZOIC
CENOZOIC
QUATERNARY
HOLOCENE
Lake, stream, wetland deposits

PLEISTOCENE
Glaciofluvial and glaciolacustrine sand and gravel deposits, glaciolacustrine clay, till

UNCONFORMITY

PRECAMBRIAN
PALEOPROTEROZOIC
Mafic Intrusions
Diabase dikes

INTRUSIVE CONTACT

ARCHEAN
NEOARCHEAN
Metamorphosed Felsic and Intermediate Intrusive Rocks
Quartz ± feldspar porphyry, feldspar porphyry, tonalite dikes

INTRUSIVE CONTACT

Metamorphosed Ultramafic and Mafic Intrusive Rocks
Peridotite, pyroxenite, schist, gabbro, diorite

INTRUSIVE CONTACT

Clastic and Chemical Metasedimentary Rocks
Wacke, siltstone, mudstone, graphitic and pyritic mudstone, conglomerate, schist, chert, magnetite-jasper iron formation, sulphide-facies iron formation

Felsic Metavolcanic Rocks
Flows, autoclastic flow breccia, tuff, breccia, lapilli tuff, schist, graphite breccia, spherulitic and quartz ± feldspar phenocrystic units

Intermediate Metavolcanic Rocks
Massive and pillowed flows, flow top and pillow breccia, tuff, lapilli tuff, tuff breccia, schist, graphite breccia, variolitic, amygdaloidal units, pyroxene and plagioclase phenocrystic units, dikes

Mafic Metavolcanic Rocks
Massive and pillowed flows, pillow and flow top breccia, tuff and lapilli tuff, schist, variolitic and amygdaloidal units, plagioclase-bearing units, leucoxene-bearing units, graphite breccia

Ultramafic and Mafic Metavolcanic Rocks (Komatiites)
Massive, spinifex and polysuture textured flows, schist, basaltic komatiite, graphite breccia, flow breccia, variolitic units

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Table 2. Description of Ultramafic Metavolcanic Rocks in Tully and Little Townships.

Map Units	1a, b, c, d, e, f, g
Field Names	Massive, spinifex-, polysuture-textured flows, talc-carbonate schist, basaltic komatiitic flows, flow breccia, graphite breccia and variolitic flows.
Location	Predominantly in the southern and western parts of Tully Township within the Kidd-Munro assemblage. In the NE corner of Little Township in the Stoughton-Roquemaure assemblage.
Colour	Fresh: black to dark green, grey schist
	Weathered: not observed at surface
Grain Size	Generally fine-grained, massive flows contain grains up to 1 mm in size.
Morphology	Spinifex and polysutured flows > massive flows > than schist and breccia. Individual flows are thin < 3 m thick but stacked flows may obtain thicknesses greater than 1 km.
Related Rock Types	Interflow graphitic metasedimentary units are common in southwestern and central Tully Township. Mafic metavolcanic units are common in the southern part of Tully Township. Interlayered with mafic metavolcanic flows in the Stoughton-Roquemaure assemblage.
Modal Mineralogy (estimated) n=12	Serpentine 0 - 40% mean = 25%
	Chlorite 0 - 40% = 15%
	Talc 0 - 45% = 15%
	Pyroxene 0 - 40% = 0
	Carbonate 0 - 50% = 10%
	Opaques tr. - 15% = 3%
	Quartz 0 - 20% = 0
	Other 0 - 58% includes rutile, amphibole, plagioclase and biotite
Comments	Thin ultramafic units are commonly contaminated with metasedimentary rocks and contain included graphite. The thicker ultramafic units commonly grade upwards from cumulate bases to spinifex-textured flows to rubbly flow tops. Flows in southwestern Tully Township appear to be coeval with sedimentation.

Table 3. Description of Mafic Metavolcanic Rocks in Tully and Little Townships

Map Units	2a,b,c,d,e,f,g,h,j,k,m			
Field Names	Massive and pillowed flows, pillow and flow top breccia, tuff and lapilli tuff, amygdaloidal, variolitic, leucoxene and plagioclase-bearing varieties, graphite breccia and schist.			
Location	In the western and southern parts of Tully township as members of the Kidd-Munro assemblage. In the northeast corner of Little Township as members of the Stoughton-Roquemaure assemblage.			
Colour	Fresh: dark green to green			
	Weathered: dark green to orange brown			
Grain Size	Mostly fine-grained < 1 mm in size. Some flows are phaneritic up to 5 mm in size, flows are generally equigranular, locally plagioclase porphyritic.			
Morphology	Pillowed flows are more common than massive flows. Flow top and pillow breccia are common. Tuff and lapilli tuff are locally abundant but are most common as narrow interflow units. Amygdaloidal and variolitic flows are more common in northeastern Little Township than elsewhere. Flows are commonly less than 10 m thick but commonly occur as thick stacked flow units.			
Related Rock Types	Ultramafic flows and intrusive rocks are most commonly interlayered with the mafic rocks in Tully Township. Graphitic metasedimentary rocks commonly occur as narrow interflow units and are commonly mixed with hyaloclastite in mafic fragmental rocks. Felsic metavolcanic flows and pyroclastic rocks are rare.			
Modal Mineralogy (estimated) n= 17	Plagioclase:	0-45 %	mean = 10	An_{32-38}
	Epidote:	0-35%	5	
	Chlorite:	10-50%	30	
	Quartz:	0-20%	10	
	Carbonate:	0-30%	10	
	Leucoxene:	0-15%	trace	
	Opaques:	0-20%	1	pyrite, ilmenite-magnetite
	Other:	0-35%	0	amphibole, clinopyroxene, biotite, serpentine, tourmaline, talc
Comments	Primary pyroxene is preserved in a number of areas. Most mafic rocks contain metamorphic minerals compatible with greenschist grade metamorphism.			

Table 4. Description of Intermediate Metavolcanic Rocks for Tully and Little Townships

Map Units	3a,b,d,e,f,g,h,j,k,l,m,n			
Field Names	Massive, flow laminated and pillowed flows, flow top breccia, tuff, lapilli tuff, lapillistone and tuff breccia, variolitic and amygdaloidal varieties, amphibole, pyroxene and/or plagioclase phenocrystic, graphite breccia and dikes.			
Location	A large, northwest trending unit extending from the southeast part of Little Township to the north central part of Tully Township. Occurs as narrow units interlayered with mafic and felsic metavoclanic rocks in the central and northwestern parts of Tully Township. Correlated with the Duff-Coulson-Rand assemblage.			
Colour	Fresh: green, grey-green, light grey			
	Weathered: brown, green and grey-green			
Grain size	Porphyritic flows are pyroxene and plagioclase phenocrystic – up to 7 mm in size in fine-grained to cryptocrystalline groundmass. Tuff breccia and lapilli tuff are common with maximum clast size up to 60 cm, avg. 3 to 8 cm.			
Morphology	Epiclastic and pyroclastic deposits are most common with subsidiary pillowed and massive flows. Fine-grained massive dikes commonly intruded the pyroclastic deposits. Well bedded and graded deposits observed at High Falls in Little Township. Poorly sorted and crudely bedded pyroclastic deposits exposed in central Little Township.			
Related Rock Types	Felsic metavolcanic and clastic metasedimentary rocks are most commonly associated with these rocks. Magnetite-jasper iron formation occurs in the north central part of Tully Township.			
Modal Mineralogy (estimated) n=6	Plagioclase:	0-40%	mean = 15	
	Carbonate:	0-45%	15	
	Epidote:	0-60%	20	
	Chlorite:	0-25%	5	
	Pyroxene:	0-30%	5	
	Quartz:	0-25%	2	
	White Mica:	0-25%	0	
	Opaques:	0-1%	trace	
	Other:	0-15%	0	leucoxene, talc, serpentine, apatite, tourmaline
Comments:	Primary pyroxene phenocrysts occur in the central part of Little Township and are interpreted to indicate a calc-alkalic geochemical affinity. Relict olivine phenocrysts occur in some of the clasts. Some clasts display trachytic textured plagioclase.			

Table 5. Description of Felsic Metavolcanic Rocks in Tully and Little Townships

Map Units	4a,b,c,d,e,f,g,h			
Field Names	Massive, flow-laminated and autobrecciated flows, tuff, lapilli tuff and tuff breccia, spherulitic and quartz ± feldspar porphyritic rocks, schist and graphite breccia.			
Location	Narrow mappable units occur within the Kidd-Munro assemblage in the northwestern part of Tully Township. A thick unit (1 km plus) occurs adjacent to mafic metavolcanic rocks in northern Tully Township. A 2 km thick unit is inferred to underlie northeastern Tully and northwestern Little Townships. A 500 m thick unit occurs adjacent to mafic metavolcanic rocks in northeastern Little Township and is inferred to be part of the Stoughton-Roquemaure assemblage.			
Colour	Fresh: white, grey, yellow and rarely red			
	Weathered: white to pale yellow			
Grain size	Flows are aphanitic to cryptocrystalline. Quartz and feldspar phenocrysts up to 2 mm in size are rare. Angular to rounded autoclastic blocks up to 20 cm in size are common. Pyroclastic fragments up to 8 cm in size are less common.			
Morphology	Autobrecciated flows and hyaloclastite are common as are massive aphanitic flows. Flow laminated and spherulitic flows are less common. Pyroclastic rocks are most common within the Kidd-Munro and Stoughton-Roquemaure assemblages.			
Related Rock Types	Mafic metavolcanic rocks are most commonly associated with felsic rocks in the western and eastern parts of the map area. Intermediate metavolcanic rocks are associated with the thick felsic units in the central part of the map area.			
Modal Mineralogy (estimated) n = 15	Quartz:	15-50%	mean = 30	
	Plagioclase:	0-35%	5	An_{8-12}
	White Mica:	10-40%	15	
	Carbonate:	10-43%	20	
	Chlorite:	0-12%	trace	
	Opaques:	1-20%	2	pyrite, graphite, hematite
	Other:	0-5%	trace	apatite, zircon, tourmaline, epidote
Comments:				

Table 6. Summary of Exploration Work for Tully and Little Townships

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Abitibi Price Incorporated	N1/2 Lot 10, Con IV, Tully Twp	1982	2 ddh - 492 m, 9 rcd - 293 m	best assay 0.005 opt Au / 5' in wacke in 1 ddh
Amax Exploration Incorporated	SE1/4 Lot 3, Con VI, Little Twp	1971	1 ddh - 153 m, ground geophysical surveys	assays not reported, graphite + pyrite encountered in ddh
Amax Potash Limited	N1/2 Lot 5, Con VI, Little Twp	1973	1 ddh - 144 m, ground geophysical surveys	nil Au, 4.6 ppm Ag/3.2' with 690 ppm Zn, 127 ppm Cu/3.5'. Massive pyrite in rhyolite fragmental
Amoco Canada Petroleum Company Limited	NW 1/4 Lot 1, Con V, Little Twp	1978	2 ddh - 334 m	0.05 opt Ag, 0.14% Cu, 0.15% Zn/ 1' in a quartz vein.
Amoco Canada Petroleum Company Limited	S1/2 Lot 12, Con I, Little Twp	1978	1 ddh - 171 m	assays not reported, graphitic metasedimentary rocks - conductor
Amoco Canada Petroleum Company Limited	N1/2 Lot 3, Con I, S1/2 Lot 1, Con II, Tully Twp	1978	3 ddh - 485 m	assays not reported, graphite breccia and graphitic metasedimentary rocks - conductors in 2 holes, no conductor in 3rd hole
Angela Developments Limited	Little Township	1986	airborne VLF-EM and Mag	no ground follow-up
Aurizon Mines Limited (H-L Mineral Holdings Limited)	S1/2 lots 1 + 3, Con VI, Little Twp	1989	6 ddh - 813 m	best gold assay reported 30 ppb/1.5m
Barrington Exploration Corporation Limited	N1/2 Lot 6, Con III, Little Twp	1965	ground geophysical surveys	no reported follow up
BP Resources Canada Limited	N1/2 Lot 2, Con I, N1/2 Lot 11, Con III, N1/2 Lot 11, Con V, Little Twp	1984	airborne and ground geophysical surveys	no follow up reported
Canhorn Mining Corporation	parts of lots 10, 11, 12, Con I + II Tully Twp	1988	owner of Nickel Offsets gold Deposit	650 000 tons @ 0.23 opt gold
Chevron	Lot 12, Con VI, Tully Twp		airborne EM and Mag survey	no reported follow up
Chiblow Mines Limited	S1/2 Lot 12, Con IV, Tully Twp	1964	ground geophysical surveys	no reported follow up

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Cincinnati-Porcupine Mines Limited	Lot 9, Con IV, Tully Twp	1969	3 ddh - 848 m	0.1 opt Au/ 1' in graphite breccia in altered mafic metavolcanic rocks
Clark, T.	N1/2 lots 8 + 9, Con I, Tully Twp	1972	ground geophysical surveys	no reported follow up
Clarke, G.	Lot 4, Con II, Little Twp	1964	ground geophysical surveys	no reported follow up
Coastal Mining Limited	N1/2 Lot 7, Con II, Little Twp	1965	ground geophysical surveys	no reported follow up
Cominco Limited	parts of lots 2- 6, Con II, Tully Twp	1984	26 rcd -	results not reported, not follow up work reported
Consolidated Novell Mines Limited	N1/2 Lot 5, Con IV, Tully Twp	1965	1 ddh - 105 m	assays not reported
Cyprus Gold (Canada) Limited	S1/2 lots 11, 12, Con III, Tully Twp	1991	9 ddh - 3527 m	deep drill testing of the Frankfield and Intex Au deposits. Confirmed depth extension of mineralization.
Daering Explorers Corporation Limited	N1/2 Lot 8, Con III, Tully Twp	1965	5 ddh - 701 m	best reported assay 0.01% Cu, 0.2% Ni / 4' in ultramafic schist
Derry, D.R.	N1/2 Lot 12, Con VI, Tully Twp	1973	ground geophysical surveys	no follow up reported
Derry, D.R.	N1/2 lots 7, 9, Con III, Little Twp	1973	ground geophysical surveys	no follow up reported
Desson, C.F.	Parts of lots 2 and 3, Con II, Tully Twp	1993	2 ddh - 440 m	best assay 0.003 opt Au / 1.1 m at contact of graphitic schist and ultramafic metavolcanic
Dome Exploration (Canada) Limited	N1/2 Lot 7, Con VI, Little Twp	1973	1 ddh - 91 m	best assay trace Au / 1.5' in quartz stringers in tonalite dike
Dome Exploration (Canada) Limited	parts of lots 10, 11, Con IV, V, VI, Tully Twp	1973	7 ddh - 1115 m	nil Au, Ag in all holes; 0.085% Cu / 15' in 1 ddh, 0.35% Zn / 15' in same ddh; 0.14% Cu and 0.25% Zn / 3' in second ddh - all assays from graphitic and pyritic metasedimentary rocks
Esso Minerals Canada	Parts of lots 4 - 7, Con III, IV, Tully Twp	1989	1987 - 6 ddh - 757 m	results summarized by Homestake (see below) best assay 26.76 g/t over 6.7'

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Falconbridge Limited	N1/2 Lot 9, Con V, Tully Twp	1989	4 ddh - 797 m	best assays - 694 ppb Au/0.15 m 500 ppm As/0.4 m; 202 ppm Zn/0.2 m; 430 ppm Cu/0.4 m; 430 ppm Ni/0.4 m
Falconbridge Limited	Little Twp	1989	airborne EM and Mag surveys	no reported follow up
Fidelity Mining Investments Limited	Little Twp	1964	ground geophysical surveys	no follow up reported
Frankfield Exploration Limited, Gowest Almagated Resources Limited	S 1/2 Lot 11, Con III, N1/2 Lot 11, Con II, Tully Twp	1974-89	diamond drilling, ground surveys	Discovery and exploration of Frankfield gold deposit; 191 000 ton @ 0.23 opt Au
Frobex Limited	N1/2 Lot 11, Con VI, Tully Twp	1965	ground geophysical surveys	no follow up work reported
Gold Shield Syndicate	S 1/2 Lot 11, Con III, N1/2 Lot 11, Con II, Tully Twp	1980	ground geophysical surveys	testing the area in and around the Frankfield gold deposit
Golden Princess Mining Corporation	parts of lots 10 - 12, Con I, II, Tully Twp	1988	44 ddh - 9005 m	drill testing Nickel Offsets gold deposit and surrounding area
Great Plains Development Company Limited	S1/2 Lot 9, Con III, Little Twp; N1/2 Lot 6, Con IV, Tully Twp	1978	ground geophysical surveys	no follow up work reported
Hanna Mining Company Limited (The)	Lot 12, Con III, Tully Twp	1972	ground geophysical surveys	no follow up work reported
Hanninen, C.	Lot 2, Con II, Tully Twp	1990	ground geophysical surveys	no follow up work reported
Hollinger Mines Limited	S1/2 lots 6 + 7, Con IV, Tully Twp	1973	7 ddh - 1263 m	0.4 opt Au / 3' in quartz vein; 5440 ppm Cu / 5', 3710 ppm Zn/ 5' ; 2500 ppm Ni /5', 20 ppm Ag / 5' other interesting assays include 0.05 and 0.07 opt Au, 1010 + 1890 ppm Cu
Hollinger Consolidated Gold Mines Limited	N1/2 Lot 2, Con III, Tully Twp	1965	1 ddh - 183 m	no assays reported

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Hollinger Consolidated Gold Mines Limited	S1/2 Lot 12, Con II, Little Twp	1965	1 ddh - 141m	no assays reported
Homestake Canada Limited	Parts of lots 4 - 7, Con III, IV, Tully Twp	1991	10 ddh - 1944 m	best results - 7.09 g/t over 0.5 m 6.22 g/t over 0.5 m; several assays between 1 - 4 g/t
Hudson's Bay Exploration and Development Company Limited	N1/2 Lot 11, Con IV, Tully Twp	1974	1 ddh - 106 m	no assays reported - in the same location as one of Placer Dome's ddh
Hydra Exploration Limited	S1/2 Lot 7, Con I, Little Twp	1964	ground geophysical surveys	no follow up work reported
International Nickel Company of Canada Limited	S1/2 Lot 11, Con VI, Tully Twp	1967	1 ddh - 209 m	no assays - complex geology indicated
International Nickel Company of Canada Limited	N1/2 Lot 1, Con VI, Little Twp	1967-68	3 ddh - 326 m	best assay - 0.3% Ni, 0.23% Cu over 1.8' in ultramafic rocks
International Nickel Company of Canada Limited	N1/2 Lot 9, Con IV, Tully Twp	1967-68	1 ddh - 234 m	no assays reported, mafic-intermediate and metasedimentary rocks encountered
Intex Mining Company Limited	S1/2 Lot 12, Con III, Tully Twp	1970 - 72	optioned ground from Texmont	delineation of gold mineralization in the "Texmont zone"
Intex Mining Company Limited	S1/2 Lot 12, Con III, Tully Twp	1988	16 ddh - 1435 m	exploration of "Texmont" gold zone; definition of 114 000 tons @ 0.22 opt Au
Jasco Prospecting Services	Lot 12, Con I, Little Twp	1966	1 ddh - 120 m	drilled under an outcrop of massive and pillowed mafic flows, no assays reported
Jelex Mines Limited	N1/2 Lot 10, Con V, Tully Twp	1965	ground geophysical surveys	no follow up work reported
Jolin, L.	S1/2 Lot 6, Con I, Little Twp	1984	ground geophysical surveys	no follow up work reported
Jordan,E.; Mason, J.	Parts of lots 8 + 9, Con II, III, Little Twp	1965	ground geophysical surveys	no follow up work reported

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Keevil Mining Group Limited	N1/2 Lot 12, Con I, Tully Twp	1969	4 ddh - 610 m	best assay 0.12 opt Au / 2.3 ' in a quartz vein, near Nickel Offsets deposit
Kidd Creek Mines Limited	Lot 1, Con II, Tully Twp	1982	4 rcd - 211 m	results not reported
Kidd Creek Mines Limited	N1/2 lots 8 + 9, Con II, Tully Twp	1982	3 rcd - 221 m	results not reported
Kidd Creek Mines Limited	N1/2 Lot 9, Con V, Tully Twp.	1985	4 ddh - 797 m	best assays - 640 ppb Au, 430 ppm Cu, 202 ppm Zn, 430 ppm Ni in graphitic breccia in felsic metavolcanic rocks
Kidd Creek Mines Limited	S1/2 Lot 12, Con IV, Tully Twp	1986	1 ddh - 191 m	no results reported
Kingdom Minerals Limited	Parts of lots 4 + 5, Con I, II, Little Twp	1964	ground geophysical surveys	no follow up work reported
Labow, L.	Lot 6, Con III, Tully Twp	1964	ground geophysical surveys	no follow up work reported
Lacana Mining Corporation	107 mining claims covering southern parts of Tully and Little twps	1980-83	31 rcd - 1597 m - 1980 14 ddh - 1923 m - 1980 4 ddh - 748 m -1982 2 ddh - 380 m - 1983	ground optioned from Rosario Resources (see below) best assay result - 795 ppb Au / 2' from 1 ddh in N1/2 Lot 4, Con I, Tully Twp
Laroma Midlothian Mines Limited	Lot 5, Con I, III, Tully Twp	1971	2 ddh - 290 m	no assays; mafic/intermediate metavolcanic rocks in 1 ddh; felsic metavoclanic rocks reported in 2nd hole
Little Tex Mining Corporation	Lot 8, Con II, Little Twp	1964	ground geophysical surveys	no follow up work reported
Magoma Mines Limited	S1/2 Lot 12, Con II, Little Twp	1970	1 ddh - 340 m	no assays reported, encountered graphitic metasedimentary rocks
Marvel Minerals Limited	Lot 11, Con IV, Tully Twp	1965	ground geophysical surveys	no follow up work reported
Massval Mines Limited	N1/2 lots 11, 12, Con V, Little Twp	1965	3 ddh - 418 m	best assay trace Au / 5' in hematized rhyolite

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Mattagami Lake Mines Limited	S1/2 Lot 8, Con II, Little Twp	1978	2 ddh - 406 m	best assay 0.009 opt Au, 3 ppm Ag, 890 ppm Zn, 178 ppm Cu
Mattagami Lake Mines Limited	N1/2 Lot 3, Con IV, N1/2 Lot 2, Con II, Tully Twp	1978	2 ddh - 372 m	best assays from N1/2 Lot 2, Con III - 0.006 opt Au in mafic flows, 3 ppm Ag, 665 ppm Cu, 1020 ppm Zn in graphitic metasedimentary rocks
Mattagami Lake Mines Limited	S1/2 Lot 11, Con IV, Tully Twp	1978	3 ddh - 560 m	best assays reported trace Au, trace Cu, trace Zn; analyses of assessment core returned <2 ppb Au, 250 ppm Ni, 120 ppm Cu, 190 ppm Zn
McIntyre Porcupine Mines Limited	parts of lots 10-12, Con I, II, Tully Twp	1969	21 ddh - 4026 m	discovery and exploration of Nickel Offsets gold deposit
McIntyre Porcupine Mines Limited	parts of lots 1-4, Con I, Tully Twp	1969	4 ddh - 472 m	Only 2 ddh reached bedrock; no assays reported
McKinnon, D.	Little Twp	1988	airborne VLF-EM and mag surveys	no follow up work reported
McMurchy, R.	N1/2 Lot 3, Con V, Tully Twp	1976	ground geophysical surveys	no follow up work reported
Mespi Mines Limited	Lot 4, Con I, Tully Twp	1967	air and ground geophysical surveys	no follow up work reported
New Calumet Mines Limited	Lot 4, Con II, Tully Twp	1968	ground geophysical surveys	no follow up work reported
Newmont Exploration of Canada Limited	parts of lots 8-12, Con IV to V, Tully Twp	1981-1984	1981 - ground IP and magnetic surveys 1982 - 5 ddh - 1120 m 1983 - 11 ddh - 1388 m (minimum) 1984 - 5 ddh - 994 m	several drill holes were not filed for assessment work credits best assays - 1982 - 0.07 opt Au, 175 ppm As 1983 - 1.41 opt Au / 3', 27600 ppm Zn, 7600 ppm Cu, 1250 ppm As, several anomalous assays between 0.03 and 0.17 opt Au 1984 - 0.15 opt Au / 4'
Nickel Offsets Limited	parts of lots 10, 11, 12, Con I, II, Tully Twp	1980 - 81	23 ddh - 6495 m	Exploration and delineation of Nickel Offsets gold deposit.
Noranda Exploration Company Limited	S1/2 Lot 5, Con I, Tully Twp	1969	2 ddh - 292 m	no assays reported

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Noranda Exploration Company Limited	N1/2 Lot 12, Con I, Tully Twp	1969	4 ddh - 448 m	Only 2 ddh reached bedrock, no assays reported
Noranda Exploration Company Limited	N1/2 Lot 8, Con III, Tully Twp	1969	2 ddh - 258 m	no assays reported
Noranda Exploration Company Limited	S1/2 Lot 9, Con III, Tully Twp	1969	2 ddh - 296 m	no assays reported
Norcen Energy Resources Limited	N1/2 Lot 6, Con IV, Tully Twp	1980	1 ddh - 300 m	no assays reported
Norcen Energy Resources Limited	N1/2 Lot 5, Con IV, Tully Twp	1981	1 ddh - 150 m	best assays - 170 ppb Au, 1.6 ppm Ag, 313 ppm Cu, 403 ppm Zn
Norcen Energy Resources Limited	N1/2 Lot 9, Con II, Tully Twp	1980	1 ddh - 170 m	best assays - nil Au, Ag, 42 ppm Cu, 68 ppm Zn
Norcen Energy Resources Limited	S1/2 lot 11, Con III, Little Twp	1980	2 ddh - 356 m	best assays - nil Au, Ag, 80 ppm Cu, 119 ppm Zn
Norcen Energy Resources Limited	N1/2 Lot 10, Con III, Little Twp	1980	1 ddh -170 m	no assays reported
Norcen Energy Resources Limited	S1/2 Lot 5, Con VI, Little Twp	1980	1 ddh - 140 m	best assays - 0.03 opt Au, 192 ppm Cu, 1700 ppm Zn, nil Ag
Norcen Energy Resources Limited	N1/2 Lot 4, Con VI, Little Twp	1980	1 ddh - 140 m	best assays - 0.13 opt? Au, 170 ppm Cu, 150 ppm Zn, 1.6 ppm Ag - gold units not specified in log - ounce gold per ton inferred
Patino Mining Corporation (The)	Parts of lots 10 + 11, Con III, Tully Twp	1965	ground geophysical surveys	no follow up work reported
Peplinski, M.	Lot 12, Con II, Little Twp	1984	ground geophysical surveys	no follow up work reported
Pickle Crow Exploration Limited	N1/2 Lot 10, Con I, Tully Twp	1969	2 ddh - 190 m	0.005 opt Au over 3' in graphitic argillite
Questmont Mines Limited	Parts of lots 7-9, Con I, II, Tully Twp	1976	11 ddh - 1215 m many holes were drilled vertically	N1/2 Lot 8, Con I - 0.01% Cu, 0.12% Zn, 0.01 opt Au, 0.03 opt Ag S1/2 Lot 7, Con I - 0.07% Cu, 0.16% Ni, 0.005 opt Au N1/2 Lot 9, Con II - 670 ppb Au, 1.1 ppm Ag, 1240 ppm Ni, 113 ppm Zn

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Romex Resources Incorporated	S1/2 lots 11 + 12, Con III, Tully Twp	1980 - 1982	5 ddh - 797 m	testing ground between Intex and Frankfield deposits - best assay reported 0.036 opt Au/1.6 m
Rosario Resources Canada Limited	107 mining claims in southern parts of Tully and Little twps	1980	ground geophysical surveys	ground was optioned to Lacana Mining Corporation (see above)
Salo, L.	Lot 7, Con IV, Tully Twp	1990	ground geophysical surveys	no follow up work reported
Samim Canada Limited	Parts of lots 1-4, Con V, VI, Little Twp	1983	4 ddh - 496 m	no assays reported
Shell Canada Resources Limited	Lot 2, Con VI, Tully Twp	1977	ground geophysical surveys	no follow up work reported
St Joseph Explorations Limited	S1/2 lots 2 + 3, Con II, Tully Twp	1977	4 ddh - 503 m	Only 2 ddh reached bedrock; best assays reported 0.24% Ni, 0.005% Cu over 1 m
Texas Gulf Sulphur Company Incorporated	S1/2 Lot 10, Con III, Tully Twp	1965	1 ddh - 123 m	no assays reported.
Texas Gulf Sulphur Company Incorporated	S1/2 Lot 8, Con V, Tully Twp	1964	1 ddh - 111 m	best assays reported from 1984 relog- 277 ppb Au, 154 ppm Zn, 58 ppm Cu, 128 ppm Ni, 2.4 ppm Ag over 1 to 1.5 m intervals
Texas Gulf Sulphur Company Incorporated	S1/2 Lot 6, Con IV, Tully Twp	1964	2 ddh - 312 m	no assays reported
Texas Gulf Sulphur Company Incorporated	N1/2 Lot 4 ,Con I, Tully Twp	1964	1 ddh - 119 m	no assays reported
Texas Gulf Sulphur Company Incorporated	S1/2 Lot 9, Con IV, Tully Twp	1964	1 ddh - 112 m	no assays reported
Texas Gulf Sulphur Company Incorporated	S1/2 Lot 12, Con V, Tully Twp	1964	1 ddh - 138 m	no assays reported
Texmont Mines Limited	S1/2 Lot 7, Con VI, Tully Twp	1969	4 ddh - 761 m	no assays reported. Magnetite-jasper iron formation encountered in 2 ddh

Table 6. (cont'd)

COMPANY	LOCATION	LAST YEAR	WORK	RESULTS
Texmont Mines Limited	S1/2 Lot 12, Con III, Tully Twp	1968	8 ddh - 1512 m	original owner; discovery and drill testing of Texmont gold zone (see Intex)
Truss, T.	Lot 12, Con II, Tully Twp	1957	2 ddh - 341 m	no assays reported - both holes encountered massive peridotite
United Comstock Lode Mines	S1/2 Lot 4, Con IV, Tully Twp	1965	3 ddh - 396 m	best assays reported 0.02% Cu, 0.005% Ni over 3'; trace Au over 2.5'
Utica Mines Limited	N1/2 Lot 5, Con IV, Tully Twp	1965	1 ddh - 149 m	best assays reported - 0.04% Cu, trace Au, trace Ag over 3.3'
Vangulf Exploration Company	N1/2 Lot 6, Con II, Little Twp	1971	1 ddh - 198 m	No assays - conductor inferred to be water filled fault
Vangulf Exploration Company	S1/2 Lot 1, Con VI, Little Twp	1971	2 ddh - 260 m	No assays reported; graphite and pyrite in felsic metavolcanic rocks - conductors
Western Mines Limited	Parts of lots 10-12, Con IV, V, Tully Twp	1980	14 rcd - 482 m 4 ddh - 350 m	best assay 0.002 opt Au / 1m
White Star Copper Mines Limited	S1/2 Lot 9, Con III, Tully Twp	1983	4 ddh - 415 m	best assay - 0.01 opt Au /5', east of Frankfield Au deposit

Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 90**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

MAPS NOT FILMED

CARTES NON REPRODUITES